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NEW YORK, SATURDAY, MAY 19, 1917

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Denver Experience Proves that Cold Weather Is No Serious Handicap to Successful Welding of Mains

Difficult Distribution Construction Job Under Railroad Yards in Midst of Winter—Novel Method Adopted to Afford Means of Readily Locating Leaks

By GEORGE WEHRLE
Assistant Superintendent of Gas Department, Denver Gas & Electric Company, Denver, Colo.

The distribution system of Denver is divided by the South Platte River into two districts which are designated by the names of North Denver and City Proper. The North Denver district is strictly a residential section which is rapidly increasing in population and which contains approximately one-fifth of the gas customers of the city.

The two districts of the city are supplied from the gas works through separate feeder mains and are connected together at three points which are controlled by valves that are ordinarily kept closed. The main feeder to the North Denver district was a 10-in. cast-iron main laid a number of years ago and which is about 3,000 ft. in length to the first branching point. It contains within this length the largest individual industrial consumer in the city, namely, the Colorado & Southern railroad shops.

Pressure Conditions

The pressure system used in Denver is a combination of medium high and low pressures. Sufficient initial pressure is carried at the works to maintain efficient utilization pressures in outlying districts and at low points, while service governors are installed on all services within the areas adjacent to the gas works and along the lines of principal feeder mains. Owing to the different load tendencies of the two districts and to the distances existing between the extremities of the main systems and the source of gas supply it is necessary to carry separate pressure schedules on the booster mains in order to obtain efficient pressure regulation within each district.

Two of the connections heretofore mentioned as existing between the two main systems are at outlying points and between mains of relatively small carrying capacities so that an attempt to use these connections to feed the North Denver district, except in emergency cases, would be impractical as it would entail a prohibitory high pressure upon the entire city district in order to maintain sufficient pressure in the other.

The third connection mentioned is near the gas plant and would be of value only in the event of trouble within the booster line between the point of connection and the valve house.

The pressures within the North Denver district are controlled by the use of an Unison Telemetric Gage, the transmitter of which is located at the determined low point and indicates at the valve house the existing pressure at that point at all times. The initial pressure at the valve house varies with load requirements from 5 to 25-in. of water column. Most of this high initial pressure was required to force the volume of gas through the 3,000 ft. of 10-in. main to the first branching point where the carrying capacity of the different mains is adequate to handle it. The Colorado & Southern shops being an off peak load has no effect upon pressure conditions.

In a survey taken recently it was found that with an initial pressure of 22-in. and no consumption between the two points but 9-in. was registered at the branching place which, computed a rate of flow of 70,000 cu. ft. per hour.

A pitot tube measurement checked this rate of flow very closely.

While the heaviest load period of the year has not been reached since the installation of the new 18-in. main we have been able to reduce the initial pressure on the North Denver booster line during the peak hour 40 per cent. The effect of this reduction in pressure upon a cast-iron pipe that was originally designed for low pressure service cannot help but be beneficial when lost and unaccounted for gas is considered. In addition to this saving the wear and tear on boosting machinery and the cost of power must be considered.

Construction Features

The need of increased carrying capacity in the way of a new feeder main for the North Denver district has been apparent for several years owing to the rapid growth and development of this district, but the installation presented several difficult features which caused its delay until recently.

Chief of these difficulties was the fact that the proposed route of the new main, which would decrease the length of pipe by approximately 500 ft., lay under the coke storage pile in the gas works yard which necessitated choosing a time for installation when the storage coke would be entirely disposed of.

That opportunity occurred this winter for the first time in a number of years.

The other difficult problems were crossing through the Colorado & Southern railroad yards containing about thirty heavily used switching tracks and crossing the Platte River.

The latter part of the plan was temporarily abandoned and the 18-in. pipe terminated at either side of the river pending action of the city in the construction of a permanent bridge.

It was found that the pressure drop in the 10-in. main crossing the bridge would not be detrimental at this time.

When the present high cost of cast-iron pipe and jointing material was considered it was decided to install a wrought-iron line with welded joints which was an innovation in Denver in gas distribution work although it had been used for several years in steam heating distribution work. It was decided to use a ratio of 3 to 1 in choosing the size of the new main and an 18-in. pipe was accordingly planned.

Owing to the conditions governing the storage of coke, work was started in January during a period of low temperatures and inclement weather which was not productive of maximum economy in installation, but could not be avoided due to the fact that the construction work within the gas works yard had to be completed in the interval between the cleaning up of the coke pile and the time storing would commence again.

The low temperature prevailing brought up a question as to whether a good job of welding could be done owing to the rapid contraction of the metal, heated in the welding process, during cooling.

Having had no previous experience under like circumstances and no data on the subject being available, the work was started under experimental conditions. The results proved, except for the discomfort of the men and perhaps a slight additional amount of gas used in heating the metal through the greater range of temperatures, that cold weather was no serious handicap to the successful welding of pipes.

In laying the 400 ft. that was installed in January and which contained 21 joints but one cracked slightly during contraction. After the job was tested out under 15 lb. pressure no leaks were apparent.

Construction Procedure

After the trench was opened the pipes were strung out along the ditch and aligned end to end in pairs. The pairs were then welded together and lowered into the trench by means of skids and chain blocks.

The pipes rested in the trench on wooden blocks cut at the top side to fit the curvature of the pipe and as long as the width of the trench. The blocks were greased to decrease friction and facilitate turning the pipe.

The pipes were turned for the welder by the use of four pairs of chain tongs until eight lengths were welded together in one continuous piece. The pipe was then raised by means of the chain falls and the blocks removed.

Final alignment and grade was then obtained and the pipe allowed to rest solidly in the bottom of the trench.

Care was exercised that the pipe rested upon the solid undisturbed soil and that no wood or other foreign substance came in contact with the metal at any point, and that no strains of any kind existed.

After the pairs were all welded into units of eight lengths each the final connection of these units was made by welding completely around the pipe. For this purpose holes were excavated, similar to those known as "bell holes" in cast-iron main construction, allowing free use of the torch at the sides and bottom of the pipe.

The welder completed on an average, under the above conditions, six joints per eight-hour day and assisted in the alignment of the pipe.

The entire work of installing the 400 ft. of main, including trenching and backfilling, occupied two weeks after which work was held up until Spring weather. During the middle of March warranted resumption under more favorable conditions. A distance of about 400 ft. of the next installment of pipe laid was under the Colorado & Southern railroad yards where in most instances only the required clearance allowed by law separated the various tracks.

These tracks had to be bridged under the direction of a railroad engineer before the trench could be opened. Six by six timbers, 10 ft. in length, were placed under and parallel with the rails resting at each end upon a short piece of the same sized timber laying at right angles thereto.

Three timbers were placed at each side of a track, close together and directly under the rails.

By this method the space excavated for timbering under the ties did not exceed four feet for each track, the bridging for all the tracks requiring two days.

After the tracks were all bridged excavating was started and accomplished by digging down between the tracks and tunnelling under them. The soil was of such a nature that it stood up under these conditions despite the traffic carried on the tracks above. This was due, however, in a large measure to the efficient manner in which the tracks were bridged.

A considerable saving in labor was made by the tunnelling method as about one-third less dirt was handled.

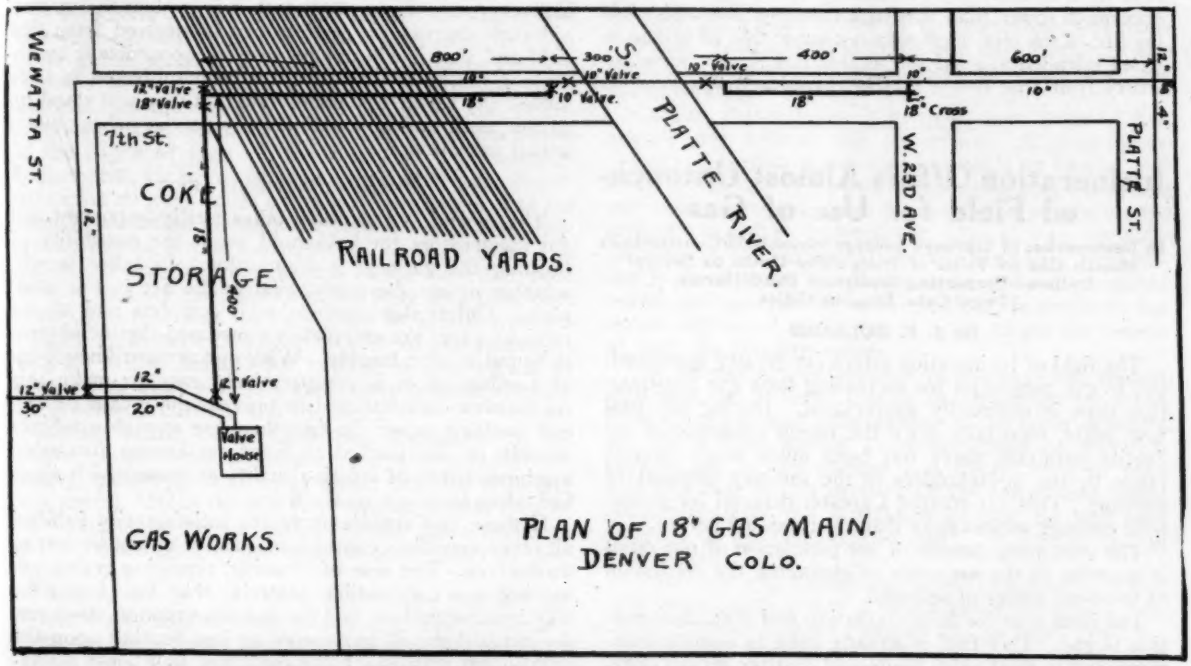
Necessary to Drag Pipe

We were able to lower pipe into the trench at but three points; at either side of the yards and at a point close to the middle. It was therefore necessary to drag most of the pipe for a considerable distance along the trench under the tracks, and all welding had to be done within the trench. The lengths of pipe were all measured up and where necessary cut with the torch so that all joints came between tracks.

As an additional precaution a 2-in. pipe was set over each joint about 2-in. distant therefrom and carried to a point near the surface of the street. These pipes are open at the bottom and capped at the top and afford a means of readily locating any leaking joints that might possibly exist in future. An accurate measurement was taken of all joints which were recorded on office plats.

The same process of welding was carried on as previously described, as many lengths as could be conveniently handled being turned for the welder with final connections welded around the stationary pipe. The pipe lying beneath the railroad yards was tested out as soon as welding was completed and the trench immediately filled.

The entire occupation of trenching, laying pipe, welding and backfilling on this stretch took about ten days. Not the least semblance of an accident was encountered during the entire job nor was switching traffic suspended in any manner during any part of the time.



LINE LAID IN THREE SECTIONS; ONE UNDER COKE STORAGE, SECOND UNDER RAILROAD YARD AND THIRD ON OPPOSITE SIDE OF RIVER

The balance of the work consisting of installing the remaining 800 ft. of main presented no difficulties and was completed in record time. The river was jumped and 400 ft. of pipe installed on the opposite side, it being the intention of the company at some future time to install either a submarine or bridge pipe of large size and continue the 18-in. main to the first branching point which will make a continuous feeder main 2,500 ft. in length that will be of ample capacity to meet the requirements of the North Denver district for a good many years to come.

The old 10-in. feeder main was left in the ground and connected to the 18-in. at four points, namely, on each side of the river, at the Twenty-third Avenue terminal and at the point where the main turns into Seventh Street after leaving the gas works. Four valves were installed; one where the 18-in. line connects with the booster main at the valve house, one between the railroad yards and gas works and one at each connection on the 10-in. main on the works side of the river. The purpose of these valves is to divide the 18-in. line into two sections; that part which lies within the gas works yard and under the coke storage pile and that part lying under the railroad yards, so that either section may be isolated in case of possible trouble while both sections could be cut out if necessary. That part lying north of the river and presenting no hazards was not valved.

The most extreme precautions were taken in purging the 18-in. main of air, both from the standpoint of safety and of service to the customers in the district supplied. A 2-in. standpipe was connected to the bottom of the main at its extremity, which was extended 6 ft. above the surface of the ground. A stop-cock was arranged in a convenient location and above this three unions were installed containing blind gaskets of 50 mesh screen.

The unions containing the screens were spaced 2 ft. apart and above the last one a hole was tapped in the pipe and a pet-cock inserted from which frequent samples of the mixture of gas and air were taken for oxygen tests.

In addition, as each test was made a rubber gas bag was filled with the gas issuing and taken a safe distance away from the purge pipe where it was ignited and tried for luminosity. Gas was turned into the system from the 18-in. line when it tested 1 per cent. oxygen and burned from the gas bag with a good luminous flame.

The 18-in. pipe was painted with several coats of bituminous paint before being installed and after welding each joint was given a heavy coating of the same paint before being covered up. All soil was carefully examined and nothing but natural clay or loam allowed to be used for backfilling. This precaution necessitated in several instances the carting of filled ground containing ashes and foreign matter away and returning good soil for filling purposes.

A Prest-O-Lite welding and cutting outfit was used

and the welding was done by a welder obtained from the Quapaw Gas Company of Bartlesville, Okla., through the courtesy of H. O. Ballard, superintendent of lines of that company. In accordance with Mr. Ballard's advice vanadium steel filler rod was used.

The cost of jointing was but little more than one-half the cost of cast lead joints in the same sized pipe at the present price of pig lead, while the permanency of the joints is so far superior as to be in a class by itself. The cost of the entire job, including labor and materials, was much lower than that of a cast-iron line and while the life of the pipe itself may not equal that of cast iron, when installed in good soil as this line is, the cause for worry from that source may be considered as negligible.

Incineration Offers Almost Untouched Field for Use of Gas

In Destruction of Garbage Average Household Consumes in Month Gas to Value of from Fifty Cents to Several Dollars—Cremating Bodies of Dead Horses, Dogs, Cats, Etc., in Cities

By J. E. BULLARD

The field of incineration offers far greater opportunities to gas companies for increasing their gas consumption than is ordinarily appreciated. During the past few years, especially since the recent epidemic of infantile paralysis, there has been much more interest taken by the householders in the sanitary disposal of garbage. This has created a greater demand for household garbage incinerators than ever existed before.

The increasing density of the population of our cities is pointing to the necessity of enforcing the cremation of the dead bodies of animals.

The ideal fuel for both cremation and other incineration is gas. This fuel is already used in some crematories and in most small household garbage incinerators. There, however, are many cremating furnaces that are fired with oil. This condition of affairs has apparently been brought about by the lack of attention that has been given to this subject by gas men and the lack of knowledge of the gas industry by the men who have built the crematory plants. It, therefore, would be well for gas men to devote more attention to all phases of incineration.

All gas men are now more or less well informed in regard to the incineration of garbage. The point on which they seem to be weakest is the fact that a garbage incinerator in order to give satisfaction over any lengthy period of time must be very well constructed. The linings of these incinerators must be able to withstand corrosive actions to which no other domestic gas appliances are exposed. Each day these machines are filled with material which is either wet or contains a large percentage of moisture. The linings of the machines, therefore, must be made to successfully withstand the action of this moisture and also resist the action of the heat and the steam resulting from the gas burned to start the combustion of the mass. At the outset this means that the incinerator must be heavily constructed and that attempts to lower the cost of the machines endanger the permanent success of the destruction of garbage by gas for the reason that a machine where the selling price rather than the operation is made the main feature is too prone to wear out rapidly and soon causes so much trouble and inconvenience that the consumer will become completely disgusted with it and be practically forced to go back to the old-fashioned, unsanitary and dangerous garbage can.

The first test on a garbage incinerator, therefore, should be a life test. The longer the machine will stand up under the severe conditions it will have to operate the more satisfactory it will ultimately prove to the consumer and the greater the consumption the gas company will eventually secure from this field. When it is considered that the destruction of garbage in the average household will consume from fifty cents to several dollars worth of gas per month it is evident that a considerable increase in revenue can be derived from this field and that it will not be wise to jeopardize it by installing machines that have not been subjected to tests sufficiently severe to demonstrate that they will stand up to the mark and give satisfactory service when put in actual operation.

Burning Without Odor

The second and the only other vitally important test for incinerators for household use is the possibility of burning the garbage without odor. In other words, whether or not the combustion in the fire box is complete. Unless this combustion is complete and all the noxious gases are completely consumed the incinerator is bound to give trouble. With our present knowledge of combustion it is comparatively easy to make this combustion complete and to prevent the escape of any evil smelling gases. In fact there are enough machines already on the market to leave no excuse for using machines either of inferior quality or those which allow bad odors to escape up the flues.

If these two requirements are satisfactorily fulfilled all other essentials can to a reasonable extent be left to themselves. The ease of cleaning, renewing grates, removing non-combustible material that has found its way into the firebox, and the gas consumption, however, are items that will have more or less bearing upon the enthusiasm with which the consumer will boost the incineration of garbage by gas and, therefore, are worthy of consideration.

Cremating Bodies of Dead Animals

In spite of the more and more universal use of the automobile and the popularity of mechanical toys there are still enough horses, cats and dogs in our cities to make the sanitary disposal of their dead bodies more or less of a problem. The most sanitary method of doing this is by cremation. The time is probably not far distant when every cat and dog hospital will include as part of its necessary equipment a crematory for burning the bodies of dead cats and dogs. In most of our larger cities we already will find crematories for horses and other domestic animals.

The fuel used in these crematory furnaces has been coke and oil, but there is no good reason why manufactured gas could not be used just as well. In an animal crematory one set of burners and one furnace is all that is necessary. Since the temperature of crematory furnaces should be maintained at about 2,000 degrees, it is usually necessary to use blast burners.

The field of incineration is only just beginning to be developed and offers the gas man an opportunity to secure the business before other fuels have been used to any very great extent. This is one of the opportunities that is offered the gas industry to get in on the ground floor. All that is necessary to grasp the opportunity is to co-operate with boards of health and the manufacturers of appliances.

Water Gas a Much More Prolific Source of Toluol Than Coal Distillation

W. H. Gartley Takes Issue with Paper of Capt. J. H. Burns on Relation of Gas Industry to Military Needs of Nation—Recovery Requires Simply Introduction of Scrubbing Apparatus and Stills

It has been commented upon before that the people who use explosives and are most interested in them never get in touch in a familiar way so as to talk the business over and compare notes with the men who manufacture the raw material from which the explosives are made, observed W. H. Gartley in discussion of the paper of Capt. J. H. Burns, of the Ordnance Department, U. S. A., on the relation of the gas industry to the military needs of the nation, presented at the annual convention of the Pennsylvania Gas Association and abstracted in this journal April 14, page 367. The reason for this is doubtless due to the fact that each class of men are specialists and are busy with their own affairs, but now that we have come to a time where a broader view must be taken because of the enormous increase in the demand for explosives it is logical to assume that there will be a great co-ordination between the primary producers and the users.

Captain Burns, of the Ordnance Department of the United States Army, has come to us with a paper containing knowledge and information that we will find very useful. He is the first to present a general view of the situation, so far as I know, to any gas association and we thoroughly appreciate the opportunity of getting it.

He says that in 1914 there were about 750,000 gal. of toluol produced in this country. I remember having lunch sometime about 1912 with a gentleman connected with a large firm engaged in the manufacture of explosives, and he censured the gas industry because he could not obtain more toluol. He later employed a chemist having particular knowledge of his needs, and the gas business to make a survey of the country to find out what toluol was available.

This was at a time when trinitrotoluol began to attract attention in the explosive world at large by its peculiar merits. His report to this company while not made public (and I have never seen it nor discussed it with the gentleman employed), would appear to bear out the statement that the capacity of the country for producing toluol was about 750,000 gal. per year. But there was one point overlooked—the capacity was 750,000 gal. at the price they were willing to pay, which was 20 to 24 cents per gallon for pure toluol.

When the war started in Europe and the necessity for the production of toluol became inexorable and prices began to soar up to something like $5.00 per gallon, new supplies began to pour into the market, so that we have Captain Burns' statement that in 1917 the capacity of this country for the production of toluol has risen rapidly to 7,000,000 gal.

The same of course is true of benzol recovery, from which is made phenol, thence picric acid, the other prominent high explosive material.

There is one statement in Captain Burns' paper which I should like to correct because it is frequently met with and is not quite accurate; that is, he says, "As I stated above, the high explosives on which the United States at present depends as fillers for shells, torpedoes, etc., are picric acid, or one of its derivatives, and trinitrotoluol—both produced from, and only from, the distillation of coal as by-products in coke and gas manufacturing."

Captain Burns takes a broader view than is frequently met with in this connection. A great many authors state that the source of supply of benzol and toluol is coal tar. If we had to depend only on the benzol and toluol procurable from the distillation of coal tar the quantity would be insignificant. Up to very recently the aims of the gas manufacturers have been very distinctly (and many good papers have been presented before gas associations on the subject) to retain all the benzol and toluol in the gas in order to get the benefit of their illuminating values.

The subject of condensation of gas has been studied with that end in view; that is, to deposit the tar freed from the gas at such temperatures of the latter as would prevent it from having a solvent action on the high illuminating vapors—benzol and toluol. Up to 1914 it is true that in this country all the benzol and toluol procurable from the distillation of coal tar was sold as crude 90 per cent. refined and C. P. benzol, and as C. P. toluol.

There was also benzol and toluol obtained in a few coke oven plants where it was washed out of the gas, but the greater source of supply was probably from the drip oils and condensates in the gas mains and floating on top of the surface of the water in the holder tanks. This material, deposited during the colder weather, was fairly rich in members of the benzol series, and while it required a large amount of gas to make a comparatively small amount of drip oil, yet it did pay some of the larger companies to carefully store it and sell it to the distillers.

As soon as the war stimulated the prices there was a great demand for this drip oil, and many of you gentlemen have had an opportunity to profit thereby. Since the war began there has also been a very rapid development in coke oven installation, particularly by steel companies who needed the coke and who took advantage of the prevailing prices to get out the benzols from the gas, there being with them no special value to be attached to the illuminating properties of these materials if left in the gas.

Toluol from Water Gas

After the war had been in progress for a time and it was found that the demand for these materials would continue, some of the gas companies began to consider whether it would not be wise to put in plants for the recovery of the benzol and toluol directly from the gas. There were two main considerations:

1. Would the demand continue long enough for them to build their plants and get their money back?

2. Could they afford to take these valuable illuminants out of their gas without disturbing their business of supply gas of standard quality to the consumers?

It must be remembered, of course, that such demand as there is for toluol, except for its use in the manufacture of explosives, is negligible.

The result of this has been, as Captain Burns says, an increase in the production of toluol to 7,000,000 gal. per year, and as the production has increased, the price of toluol has rapidly fallen from these high prices which stimulated production during the first year of the war.

It is a curious point that we gas men have allowed to go unchallenged so long statements similar to that of Captain Burns—that the only source of supply of benzol and toluol is as by-products from the distillation of bituminous coal. As a matter of fact 75 per cent. probably, of all the gas manufactured by gas companies in this country is water gas, and water gas is a more prolific source of toluol than coal gas. The amount of toluol that is carried by a 20-candle-power water gas is more than is carried by the same quantity of a 16-candle-power coal gas. Consequently, this field is the one that is most available for a quick increase in the supply of toluol. A 22-candle-power water gas will contain something like 1/10th of a gallon of toluol per thousand cubic feet. This field is almost untouched in the United States and it requires simply the introduction of the necessary washing apparatus and stills to take this toluol out of the gas and purify it.

In the coke oven processes nearly all of them now have their washing plants, so that to get more toluol from them would require the building of more coke plants, and of course the recovery of benzol and toluol is only of secondary importance in these plants.

The light oil that can be recovered from the gas by washing the gas with a certain heavier oil (known as wash oil) will consist of a mixture of benzol, toluol, xylol, naphtha, solvent naphthas and some naphthalene oils. It is possible to separate these, first, from the wash oil and afterward, in a properly designed still, from each other, and put the benzol back in the gas when needed for candle-power. After the benzol, the material coming off from the still would be the oils rich in toluol, which can be set aside for refining processes. The materials remaining in the still will be, generally, the xylol, naphthas and heavier oil. Some little solvent can perhaps be combined with the benzol, if necessary, to be put back in the gas for enrichment, but as a rule it will be found that the naphthas are not very useful because they will drop out of the gas nearly completely and very quickly. If you can afford to reduce your candle-power to the extent of keeping out the benzol, then you would have raw materials for the manufacture of both trinitrotoluol and picric acid.

Now, of course, both these materials require nitric acid. Nearly all explosives are nitrated products. The supply of nitric acid is going to be the one great problem for this country in the next few years. We can get nitric acid from the nitre deposits of Chile as long as we command the seas and have the ships to carry it. But the demand for shipping is now so great that it is hard to conceive of adequate tonnage plying between Chile and the United States carrying nitrate of soda.

Germany found herself in this condition as soon as the war opened, and she took advantage of investigations and research that has been made toward the obtaining of nitrogen from the air. Several processes have already been tried with success and of these one of the most prominent was the Ostwald which had been invented in Germany some eight or nine years before the war but which had not been taken up to any extent, the process not having been developed into a thoroughly commercial one. But when the demand for a product is as insistent as that for nitric acid was in Germany every possible effort had to be used to carry on the experiments to a successful conclusion; and it was recently stated by Dr. Cushman, of Washington, that the Germans went very rapidly through some forty thousand different tests of the Ostwald process until they came upon one by which it jumped immediately into a most successful and practical method. This process uses gas works ammonia, purifies it and then passes it with air over heated platinum which acts catalytically to convert the nitrogen of the ammonia into NO_3.

Production of Nitric Acid

The other source of a supply of nitrogen is the fixation of atmospheric nitrogen; that is, the taking of pure nitrogen from the air and chemically combining it with some other materials. The prominent methods are:

The "arc" process which simply passes air through a high power electric arc.

The Haber process, which directly combines pure hydrogen and pure nitrogen from the air to form ammonia.

The cyanimid process, a complex chemical operation that would appear to be difficult but which undoubtedly is very successful.

The cyanide process, in which the nitrogen of the air is made to combine with carbon and form sodium cyanide.

And other processes that are still in the experimental stage.

The United States Government has already appropriated some $20,000,000 for the building of a plant to recover nitrogen by the cyanimid process, the purpose there being to build a plant that can be used by the Cyanimid people to make fertilizer during peace time, and can be used by the Government to produce nitric acid during war time. This combination was necessary here because the Cyanimid Company could not, under the laws of this country, get a sufficient amount of hydro-electric power to warrant them putting up a plant. No single individual or corporation can procure and control such an amount of hydro-electric power under our laws. This makes the Cyanimid Company a rather Governmental concern.

The interests of the gas companies, however, will lie in the development of these processes which will convert our ammonia into nitric acid. This requires no great heat and no concessions by the Government for hydro-electric power. It is distributed pretty generally throughout the United States and I think it is ideally intended for the manufacture of nitric acid; so that we may expect, under the urgent necessity that prevails, and will continue to prevail, to see a rapid development in this industry.

Therefore, we have the gas companies producing not only the benzol for picric acid manufacture, the toluol for trinitrotoluol manufacture, but also the ammonia for the manufacture of the vitally important nitric acid, without a vast amount of which no country can hope to carry on a successful war.

Again, the condition of the gas business is such as to be more favorable to the production of these materials than it was a few years ago for the reason that throughout the country at large there has been a change from a candle-power standard of value to a heat unit standard of value, and since the recovery of toluol from both coal gas and water gas can be effected with small loss

in heat units (although a very considerable loss in candle-power), the gas companies at large are able now to recover these vapors.

Therefore, Captain Burns is not quite correct when he makes the statement: "that the consumers of illuminating gas have not adjusted themselves in this country to the use of gas that has been stripped of its illuminants."

Pyrometers — Past, Present and Future

Richard P. Brown Traces the Evolution of High Temperature Measurement from Days of Brick-Baking Ancients to Modern Times and Forecasts Future Possibilities

As far as we know the ancients who baked excellent bricks and forged iron in their crude way made use of a form of pyrometer used to-day with ever diminishing success, the "Eye," declared Richard P. Brown, president of the Brown Instrument Company in a paper before the Steel Treating Research Club of Detroit.

Doubtless the Egyptian looked into a kiln and guessed the fire must be about right. He probably wasn't off more than a couple of hundred degrees, and very probably he guessed the temperature a great deal more accurately than some so-called pyrometers of later date. His eye was also much clearer than the eye of some of the modern furnace men who see almost any temperature in a furnace, depending on the amount of sleep they have had the night before.

At a very early date attempts were made to measure temperature by the expansion, contraction or fusing points of clay. Wedgwood, a potter in England, measured his kiln temperatures in this manner in 1782. To-day cones of clay are still in extensive use in brick and pottery plants. These cones, of which this is a sample, are formed of various substances so mixed as to form a whole series with a fusing or softening point about 20 deg. apart.

A set of these cones are usually placed side by side in a kiln where they can be viewed through a peep-hole with fusing points, for instance, of 2100, 2120 and 2140 deg. Fahr. respectively. When the first cone softens and falls over, it indicates that a temperature of 2100 deg. Fahr. has been attained, and the firing stops. If the other cones are still standing, it will indicate that the temperature has not exceeded 2120 deg. Fahr.

Shortcomings in Clay Cone Method

Unfortunately cones are affected by both time and temperature, and they will soften or fall over at a higher temperature when heated up slowly for 100 hours than when heated to the softening point in an hour or two. They are not suitable for use in heat-treating furnaces for this reason, although attempts have been made to use them.

Along this same line I should mention some fusible salts which have recently been brought out. There is quite a range of these capsules which seem to give reasonably satisfactory results. They can be placed on a piece of steel in the furnace, and will indicate by melting when a certain temperature has been attained.

Mercurial Thermometer

One of the early devices to measure temperature was the mercurial thermometer, with which every one is familiar. Mercury thermometers for temperatures up to 600 deg. Fahr. have a vacuum above the mercury column. As mercury boils at 674 deg. Fahr., thermometers graduated above this must have the mercury column under pressure to prevent boiling. A mercury thermometer graduated to 1,000 deg. Fahr. has 200 lb. pressure above the mercury column. This is about the limit for a mercury thermometer, as the glass tubing will soften at temperatures above this, and the pressure necessary to prevent boiling becomes excessive.

The first mechanical pyrometers operated through the difference in expansion of iron and brass. An iron tube containing a brass rod projected into a furnace, and these were mechanically connected to a multiplying movement which caused the pointer to pass around a dial. The difference in expansion of about ⅛ in. was sufficient to move the pointer up to 800 deg. Fahr. This form of pyrometer has a tendency to change in its reading with time and temperature, due to the coefficient of expansion of the metals changing through continuous heating and cooling. This occasions frequent readjustments of the pointer to compensate for this error.

Gas or Air Thermometer

The metallic expansion pyrometer was the most largely used in heat treating, glass annealing and blast furnaces during the period between 1860 and 1890, and this type of pyrometer is still largely used to-day in bread baking ovens where an accuracy within 50 deg. is sufficient.

The gas or air thermometer, another form of expansion instrument, was the device originally used to determine the true temperature scale, yet it seems strange that it is comparatively recently that this type of instrument has been used to any extent to measure temperature commercially.

It consists of a copper bulb containing nitrogen gas, connected to a recording gauge by a very small bore capillary tube, which is protected by a heavy flexible steel tube. The recording gauge contains a spring similar to the Bourdon springs in steam gauges.

When the bulb is heated in a furnace the gas inside expands and the pressure exerted along the capillary tube expands the spring in the instrument and causes the pointer to read across the chart or scale.

For a temperature of 400 deg. Fahr. the pressure exerted on the spring is about 200 lb. In consequence, a heavy spring can be used and the instrument is of very robust construction. Temperatures, however, with this instrument cannot be measured above 1,000 deg. Fahr. Future development work may result in designing an instrument of this type for practical use at temperatures above this.

Measurement by Water Passing Through Pipe in Furnace

An early form of temperature measuring device, and one which might seem exceedingly simple, consisted of a pipe which was run through a portion of the furnace, and water passed through this pipe under a constant pressure. Thermometers at the inlet and outlet measured the temperature of the water and the rise in temperature of the water, while passing through the furnace was equivalent to a certain actual temperature in the furnace. The trouble with this form of temperature measurement was the leaks which frequently developed in the pipe, working havoc with the

interior of the furnace. While the pipe heated up very little, due to the cold water passing through it, it seemed impossible to obviate leaks entirely.

An instrument used quite largely thirty or forty years ago was the Siemens Water Pyrometer. A copper ball, weighing exactly 137 grams, was placed on a piece of steel in the furnace, and after it had fully attained the temperature, it was quickly removed from the furnace and dropped into a vessel containing a thermometer and exactly one pint of clean water. The rise in temperature of the thermometer in the water could be read off in actual temperature degrees on a corresponding scale. The accuracy of this instrument necessarily depended upon exact measurement of the quantity of water in the vessel and the weight of the copper ball, which scales away slowly under heat; also the time taken to remove the ball from the furnace and drop it into the water must vary slightly An accuracy within about 25 deg. Fahr. was, however, usually attained with this instrument.

The Siemens Water Pyrometer is still used to-day by armor plate manufacturers, as they can readily place a number of copper balls on a piece of armor plate which cannot be easily reached by more improved pyrometers. I noticed one of these instruments in use at the armor plate department of the Bethlehem Steel Company a few days ago.

Optical Pyrometers

There have been a number of different forms of optical pyrometers developed, all of which compare either a light or different colors to that of the piece of steel in the furnace, the temperature of which is to be measured.

Instruments have been developed by Morse, Holburn-Kurlbaum, and Wanner, in which a bright filament of light is compared with an incandescent background. Mesure and Nouel, the Shore Pyroscope, the Eye-Rite, and other similar instruments, compare colored glass or colored substances to the color of the piece in the furnace.

The trouble with all these instruments is that no two operators using the instrument get the same result. They are supposed to help the eye in determining temperature by comparison. They very frequently seem to do more harm than good. Where no other form of temperature measuring device can be satisfactorily used it may be necessary to resort to an optical pyrometer, but they are hardly to be recommended otherwise.

Resistance Thermometers

The principle on which resistance thermometers operate is the change in resistance of metals due to change in temperature. A coil of platinum or pure nickel wire, protected with a suitable protecting tube is inserted at a point where the temperature is to be measured, and with a constant source of current passing through the coil of wire the resistance increases or decreases, depending on the temperature. This change in resistance can be easily measured, as an adjustable resistance is used to balance the resistance of the bulb, and a galvanometer shows when the balance is reached. The adjustable resistance with sliding contact arm can have a temperature scale for direct reading.

This instrument is an exceedingly accurate one for measuring low temperatures, but is hardly to be recommended for high temperature service. The nickel bulb can be used for temperatures up to 300 deg. Fahr., but above this platinum has to be resorted to, and, in consequence the bulbs are necessarily very expensive. Furthermore, an outside source of current is necessary with this instrument, and this current must be reasonably constant. Dry-cells, storage batteries or lighting circuits must be utilized. While this form of temperature measuring instrument has been used to some extent for higher temperatures, its chief application is for temperatures below 300 deg. Fahr.

Thermo-Electric Pyrometers

For measuring temperatures above 1000 deg. Fahr. the thermo-electric method has come to be by far the most largely used. Possibly some here may not be familiar with the manner in which a thermo-electric pyrometer operates, and it might be well for me to describe this briefly.

A thermo-electric pyrometer consists of a thermo-couple, a measuring device, and the wires connecting the thermo-couple and the measuring device.

If you take two pieces of wire of different materials; for instance, one wire of copper and one of iron, and join one end of the wires together, then heat the junction, you will generate a small current of electricity. This is known as thermo-electricity, and the wires comprise a thermo-couple.

It is true that the current generated is very small. Wire of precious metals for high temperature measurements, such as one wire of platinum, and the other of 90 per cent platinum, 10 per cent rhodium, generate only ten-thousandths of a volt or 10 M.V. at a temperature of 2000 deg. Fahr. Wires of base metal, such as iron and copper nickel for measuring moderate temperatures, generate several times the voltage of a platinum thermo-couple, or about 50 M.V. or fifty-thousandths of a volt at 2000 deg. Fahr.

Experience seems to show that for measuring temperatures up to 200 deg. Fahr. a thermo-couple of bismuth and antimony is best. For temperatures to 1000 deg. Fahr. a satisfactory thermo-couple consists of one wire of iron, the other, 60 per cent. nickel and 40 per cent. copper. For the measurement of temperatures as high as 1800 deg. Fahr. a very satisfactory base metal thermo-couple consists of one wire of 90 per cent. nickel and 10 per cent. chromium, the other wire 98 per cent. nickel and 2 per cent. aluminum. The General Motors Company of Detroit have developed a base metal thermo-couple of their own, known as Simanial, and its name indicates that this thermo-couple consists of silica, manganese, nickel and aluminum.

While it is possible for short periods of time to run base metal thermo-couples about 1800 deg. Fahr., for constant service above this a thermo-couple, one wire of which is chemically pure platinum the other platinum 90 per cent., rhodium 10 per cent., is to be recommended.

Thermo-couples of base metal are manufactured of all diameters running from one-hundredth of an inch up to one-quarter inch wires. Some particular tests require thermo-couple wires of exceedingly small diameter to secure sensitiveness and quick readings.

There is no doubt but that heavier wires forming the thermo-couple will increase the life where a base metal thermo-couple is in constant service at temperatures up to 1600 or 1800 deg. Fahr. While a heavier thermo-couple slightly increases the lag, this is not noticeable in heat treating furnaces.

(Continued on page 494)

100 Lb. of Coffee Roasted at Fuel Cost of 7 Cents for Gas

Process Requires 28 Minutes with 330-Lb. Batch—Fine Temperature Control a Necessity for High Quality Work—Installation a Conversion of Coal-Fired Roaster

By HENRY L. READ
Engineering Department, Surface Combustion Company, Long Island City, N. Y.

In coffee roasting, efforts are made to get a uniform product roasted to just the desired degree, no more, no less; as the flavor is apparently affected by slight variations in this treatment.

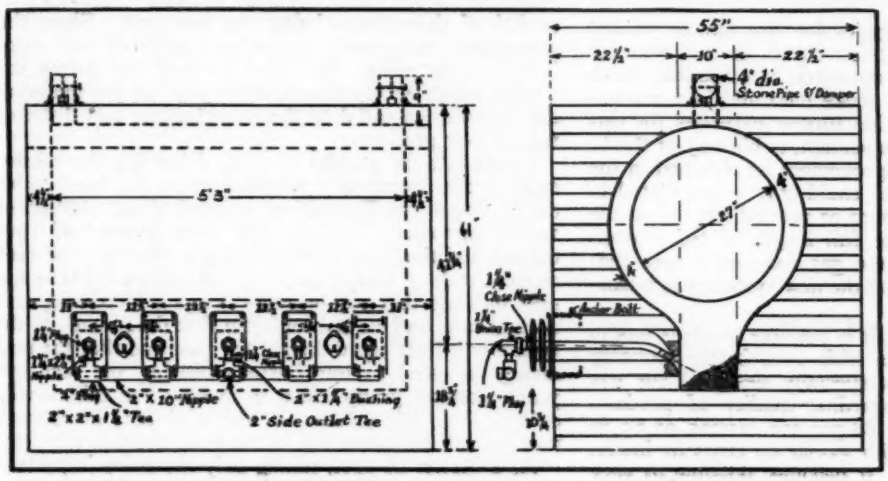
The usual method of conducting the operation is to heat the beans in a horizontal perforated steel cylinder rotating over hot coals in one half of the setting, the products of combustion from which keep the other half of the appliance up to temperature. Through the holes in the side of the cylinder the broken shells from the coffee fall and are consumed in the fire at once or caught in a pan of water to prevent smoldering, since the smoke they give off is deleterious to the work. These openings are, of course, small enough to prevent any of the beans from being lost. The time required and the temperature depend on the grade, but ordinarily about twenty-five minutes, with a maximum of 350 to 375 deg. Fahr. is satisfactory. The heating is done in batches. The coal cost is generally about 1 to 1½ cents per 100 lb. of coffee, using anthracite pea coal at $3 to $4 per ton.

Gas has been used mainly on small roasters with a consumption of about 80 cu. ft. of 600 B.t.u. gas per 100 lb. and the roaster is of a design suitable only for gas. Attempts to convert existing coal-fired roasters have generally resulted in excessively high gas costs, and in addition have not turned out a satisfactory product.

Utilizing Existing Equipment

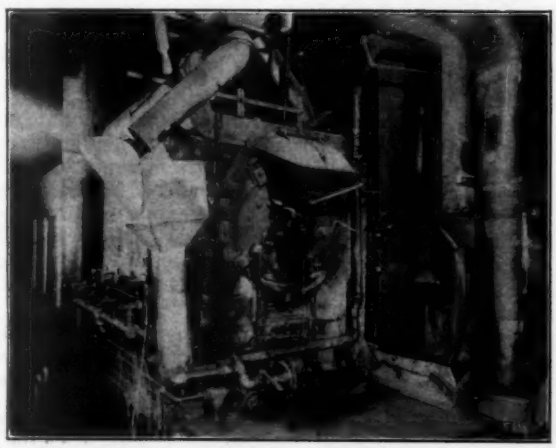
In the last few months surface combustion has been applied to this work with very satisfactory results. A firm in a large city in the East, which had for a long time used gas under its roaster, was persuaded by the gas company to try the new style burners in hope of reducing its bill, which had become a serious item.

The existing equipment consisted of four drilled port pipe burners in what had once been a coal grate. The fire was as usual under the front or discharge end of the machine, extending half way back. The burned products traveled to the rear and escaped there through a suitable flue, keeping the back part hot. To the burners were brought, in the customary manner, gas under 3 in. of water and air from a positive pressure blower under 1½ lb. per square inch.



IN GAS INSTALLATION FIRE EXTENDS FULL LENGTH OF APPARATUS, THEREBY GIVING THE COFFEE THE BENEFIT OF RADIANT HEAT FROM THIS SOURCE

The surface combustion outfit was installed as shown in the side elevation, Fig. 1, and the section, Fig. 2, Part of the brick work was rebuilt to meet the new requirements, which necessitated likewise a particularly long burner of the now familiar impact type in order to locate the refractory bed under the middle of the cylinder. It was decided, after some discussion, to have the fire extend the full length of the apparatus instead of only half, as before, and thereby give all the coffee the benefit of the radiant heat from this source.



COMPLETED INSTALLATION A CONVERSION OF COAL-FIRED ROASTER TO GAS

Consequently, to make the control more flexible, two flues were provided, one at each end, with dampers.

The available air supply was made use of, since this was a low pressure installation, and the regular surface combustion proportioning inspirator, which automatically holds constant and correct the proportions of gas and air with a single valve and eliminates the need of adjusting two valves when more or less heat is desired. The accompanying photograph shows the completed job.

The new equipment was tested by the gas company's engineers and checked by the purchaser's monthly gas bill. The figures for the test were as follows:

Amount Coffee	Required	Gas used	Rate Gas per Hour	Gas per 100 lb. Coffee
330 lb.	(2 bags)	28 minutes	224 cu. ft.	480 cu. ft.	70.9 cu. ft.

The consumer's own figures for one month showed that with gas at $1 per 1,000 cu. ft. it cost him for fuel very close to $0.07 to roast 100 lb. of coffee, which is in accordance with the above data and is a marked increase in economy over his former expenses for this purpose. But even more important, to his way of thinking, was the very great improvement he obtained in the quality of the output, which could only be attributed to the effect of the large amount of radiant heat from the refractory bed running the full length of the roaster. He voluntarily informed the gas company's men that the character of the work by the new system was unsurpassed.

It will thus be seen that it is possible to apply gas to existing coal-fired roasters with even better economy than obtained by roasters specially designed for gas and far better results regarding quality of product. With coal prices at $6 or $8 per ton instead of $3 to $4 as given above, and with gas at 80 cents or lower, as it is in many localities, it becomes possible to very nearly meet the coal costs even without considering any saving in labor or increased cleanliness, etc.

Purchasing Power of Dollar Cut in Half in Obtaining Materials Necessary for Public Utilities

A. F. Hockenbeamer Gives Figures in Regard to Prices Pacific Gas & Electric Company is Paying—Greater Outlays Must be Covered in Rates Unless Development is to be Arrested

Our expenses and taxes in 1916 increased $353,000 causing a decline in net operating revenue of $138,000, declared A. F. Hockenbeamer, vice-president and treasurer of the Pacific Gas & Electric Company, in his report submitted at the Stockholders' Meeting, held April 10. This upward tendency of costs has become decidedly more marked since the first of the year. The cost of practically everything entering into the products and service which we have to sell has advanced in price, and in many items to an unprecedented degree.

As a matter of fact, the purchasing power of a dollar with respect to the bulk of the material entering into our maintenance, replacements, construction and operations has been cut in two, and at present prices it requires about two dollars to do the work formerly performed by one.

We have selected twenty-nine representative articles in common use in our gas and electric departments, and taking the actual quantities of these bought by us in 1916 and applying to these quantities prices prevailing before the outbreak of the war, prices a year ago and prices now prevailing, obtained the following results:

Cost at prices in January, 1914	$617,000
Cost at prices in January, 1916	796,000
Cost at prices in January, 1917	1,242,000

The foregoing tabulation is exclusive of oil, which has gone up more than 50 per cent and at present prices will cost us about a million dollars more in 1917 than it cost in 1916.

It will be noted from the foregoing table that between January 1914 and January 1916 there was an average advance in the cost of materials of 29 per cent and between January 1916 and January 1917, a further advance of 72 per cent, the total advance for the entire period of three years being 101 per cent. Since this compilation was made, prices have gone up still more. There is no public regulation to limit the prices and profits which we are compelled to pay for the materials and supplies essential to the manufacture and distribution of our products.

In the last six months of 1916, following the subsidence of the reactionary influence upon our business of the closing of the Exposition, we made a net addition of 14,879 customers. In the first three months of 1917 the net addition was 3,747, making a total for the nine months ending March 31, 1917, of 18,626. These figures indicate that our business is again increasing at a normal rate, and we are confident that the growth of the future will fully equal that of the past and that the new money invested in our business during the last five years, coming pretty close to twenty-five millions of dollars, is a fair measure of the additional investment that we will have to make in the next five years.

As a matter of fact, taking only the more important items of work, we have to-day more than two million dollars worth of construction under way. It has always been your company's policy to put into its business whatever new money was required to provide the additional facilities necessary to properly and adequately serve the public, and it will undoubtedly continue this policy to the full extent of its resources.

It is obvious, however, that the ability of any utility to attract new capital depends upon its credit, and credit is chiefly a question of the difference between income and outgo, that is, whether, after paying maintenance, operating expenses and taxes and setting aside adequate reserves for depreciation and other contingencies, there is enough left to pay interest and dividends with a margin amply sufficient to safeguard the investor's income and approximate the margin of safety earned upon other securities offered to investors in competition. In view of the tremendous demands about to be made by the Government on loanable funds, new capital for private enterprises will for some years unquestionably cost more and be more difficult to obtain.

Symptoms of this are already in evidence in the general decline in investment bonds, postponement of new financing, or in the substitution in new financing of temporary for long-term obligations. In the circumstances of higher taxes and higher costs for practically everything that enters into their products, including new capital, it is essential that utilities be permitted to recover these greater outlays in their rates unless development is to be arrested or brought to a standstill.

Describes Experiences in Distributing Mixed, Manufactured and Natural Gas

Alexander B. Macbeth Brings Out Interesting Details in Regard to Los Angeles Experiences—Companies Now Sending 50 Per Cent Mixture

The city of Los Angeles has a population of 556,000, and is surrounded by many smaller municipalities having a combined population of 194,000.

The Midway Gas Company, which is a production and pipeline company, delivers natural gas to Los Angeles through two lines, one twelve in. line entering the city from the north, from Taft in Kern county, California, is 111 miles long, with a delivery capacity of about 20,000,000 cu. ft per day; and one eight in. line, coming into the city from the south, supplies gas from the so-called Whittier-Fullerton field, twenty miles southeast of Los Angeles, and has a capacity of 10,000,000 cu. ft. per day.

All gas delivered by the Midway Gas Company is delivered to the Los Angeles Gas & Electric Corporation, having 135,000 consumers, and the Southern California Gas Company which has 28,000 consumers of its own and supplies other companies having 27,000 consumers. The Los Angeles Gas & Electric Corporation distributes a mixed gas containing fifty per cent natural gas. The Southern California Gas Company which is under the same management as the Midway Gas Company (the natural gas company) supplies all of its consumers in the city of Los Angeles with a mixture containing fifty per cent natural gas, and to the remainder of its consumers some straight natural and some mixed gas, and in like manner, distributes to some of the companies it supplies straight natural gas, and to others a mixture of manufactured and natural gas in proportions of fifty per cent and these companies in turn distribute to their customers the gas supplied by the Southern California Gas Company.

The maximum combined daily sendout of gas of all characters to supply these 190,000 consumers, in the winter of 1916-17 was 36,535,000.

The climate of Los Angeles is very different from that of almost any other city in the United States. The temperature seldom drops below forty degrees. The days are warm in the winter time and the nights are cool in the summer and the amount of fuel required for domestic use for heating purposes is very small.

Very little gas is used for illuminating purposes, electricity supplied from hydro-electric plants being sold at very low rates, and gas for lighting has never been pushed. Gas is universally used for cooking and heating water in residences, but in hotels, apartments and large buildings, distillate, purchased at a very low price, is used to a large extent. While the amount of gas used in furnaces has increased somewhat since the introduction of high heat unit gas, a large amount of domestic heating is still done with distillate, coal, wood, carbon briquets which are the competing fuels.

These details were given by Alexander B. Macbeth, vice-president and general manager of the Southern California Gas Company, in introduction of his paper on mixed, manufactured, and natural gas distribution in cities, presented at the annual convention of the Natural Gas Association of America, at Buffalo, May 15-17, from which the following has been abstracted:

The natural gas supplied by the Midway Gas Company is for the most part of two kinds. The chemical analysis, gravity, and heat values, first of the natural gas from the Kern County Fields and then of that from the Whittier-Fullerton Fields are as follows:

KERN COUNTY FIELDS GAS

	Per cent.
CO_2	5.0
Ill	0.4
O	0
CO	0
C_2H_6	14.9
CH_4	79.0
N	0.7

Spec. Gr. .72 1,120 B.t.u.'s

WHITTIER-FULLERTON FIELDS GAS

	Per cent.
CO_2	0
O	0.4
CH_4	84.0
C_2H_6	15.6

Spec. Gr. .778 1,208 B.t.u.'s

The following is the analysis of the manufactured gas distributed in Los Angeles before the introduction of natural gas, being an oil gas made by the single cylinder process.

	Per cent.
CO_2	0.5
Ill	4.1
O	0.2
CO	8.1
H_2	46.4
CH_4	37.6
N	3.1

Spec. Gr. .549 674 B.t.u.'s

The analysis of the manufactured gas which at the present time is being mixed with the natural gas being distributed is:

	Per cent.
CO_2	4.6
Ill	.6
O	.7
CO	13.6
H_2	53.2
CH_4	26.1
N	1.6

Spec. Gr. .44 535 B.t.u.'s

Natural gas was first introduced and a mixed gas furnished to domestic consumers in Los Angeles in the latter part of 1913. At that time, varying mixtures were furnished to consumers, but for the most part this mixture varied from fifteen per cent to forty-five per cent of natural gas.

In the early part of 1914, straight manufactured gas was again furnished and continued until the first of August, 1914, at which time the companies commenced to distribute a mixture consisting of fifty per cent natural and fifty per cent manufactured gas, which has practically been maintained since that time. This change from artificial gas to gases containing varying amounts of natural gas, up to fifty per cent was done without any inconvenience or complaint from consumers whatever.

RATES CHARGED

On account of the limited amount of natural gas to be obtained it has been deemed best to continue the fifty-fifty mixture up to this time and to sell the surplus gas for industrial purposes. This may be changed by the State Railroad Commission which now has the matter under advisement.

(*Continued on page 497*)

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Business at a Faster Pace than Ever Before

Serious injury to the welfare of the country was threatened for a time by a few hasty utterances of public officials, which were interpreted to mean that if our shoes, for instance, had reached the state where ordinarily they would be replaced with new ones, we should drag along shabbily shod for a few months more —for the sake of economy. Economy—not sensible economy, but silly, unreasoning, economically destructive retrenchment—became, for a few days, the watchword. Then the slogan "Business as usual" came to the rescue. But even this slogan, though it is commendable, is not sufficient for the gas industry if it is to do its full duty to the Nation. In our case it must be "Business at a faster pace than ever before."

A certain amount of new construction; extensions, betterments and replacements, are an absolute necessity —almost a matter of routine—to any developing company. If postponed or deferred, inadequate and unsatisfactory service results, and the development of the utility is stopped, which injures directly the interests of the community it serves. The consumer does not desire this, and, if the facts are plainly put before him, the consumer will willingly pay the cost of averting it.

Gas companies should not consider for a moment the matter of deferring improvements or developments. They should consider rather means of offsetting the obstacle of the high costs of materials. A simple modification in standards may in some cases accomplish this to a sufficient extent. In other cases rate adjustments may be necessary.

Acquainting the Industrial World with the Advantages of Gas as a Fuel

It is somewhat surprising, in the light of the frequent assertion that the difficulty the country faces in the matter of shell manufacture, guns, etc., lies not in the lack of raw steel, but in the lack of equipment to turn it into the products that are needed, that we hear so little of gas equipment for this purpose.

The oldest manufacturer of gas furnaces has been a consistent advertiser in engineering mediums outside of the gas field, preaching the doctrine of "Gas is the ideal fuel." Various companies in large centers have preached the doctrine of gas for industrial fuel in the daily press.

But these efforts, rightly directed though they are, are mere drops in the bucket. The task is a much greater one than such isolated efforts can accomplish.

Logically the national advertising of gas is a responsibility that rests on the shoulders of the equipment manufacturer. To accomplish it adequately there should be a consolidation of effort, a pooling of interests. As an example we might cite the advertising of cast iron as a pipe material which appears frequently in this

and other gas journals, as well as practically every other journal in the country that in the opinion of these interests reaches those who use pipe for any purpose to which cast iron applies. It is a campaign that is essentially educational in nature and does not seek direct returns or sales.

The experience of manufacturers of electrical equipment has shown that national publicity pays; not only in the benefit the individual central station which pays nothing directly towards its cost receives from it, but in the return which the manufacturer is bound to get from it.

As matters stand in the industrial fuel gas field the gas company's industrial man is placed in the position of not only having to make the sale, but to create the demand as well. To secure the results he *can* obtain the manufacturers—not one or two of them, but all—should relieve him of the latter functions.

A properly handled publicity campaign would have the effect of getting manufacturers to call upon the gas company to learn what it could do for them in applying gas to their work; in other words, getting prospects to introduce themselves rather than, as is now very largely the case, of having to hunt them down.

Accuracy in Advertising

A speaker at a recent association convention takes to task the automatic water heater manufacturers for using such slogans as "Hot water at the turn of the faucet," "Hot water quick as a wink," etc., when, as a matter of fact, in all his experience he has never yet encountered a water heater that gives these exceedingly gratifying results.

The gas industry owes a great deal to certain automatic water-heater manufacturers. They are national advertisers to no small degree and have done a great deal in recent months at a considerable expense to keep gas in the public mind, and to prevent through sheer neglect from getting the impression gas is a back number. They have in this manner rendered a service to even the smallest gas companies similar to the service various electrical manufacturers are rendering which makes the way much easier for the electric central station to increase its load.

For this reason this journal looks with a particularly friendly eye upon the manufacturers of automatic water heaters. The gas industry needs national advertisers, and there is by far too few of them in its circles. It is a task that seems logically up to the manufacturer of appliances, yet it is a task which other manufacturers—except, to an extent, the gas range maker—have left the water heater manufacturer shoulder pretty much alone.

There is reason, however, in the complaint the speaker in question gives voice to. The manufacturer naturally seeks to create a sentiment leading to a sale. His water heater he knows is a good one and is a convenience. Once the sale is made, however, the burden is shouldered on the gas company. It has actually closed the sale, and, in effect, has guaranteed the accuracy of the statements that are made in the catalog the manufacturer has printed, but which the gas company distributes.

That the quality of producing hot water at the snap of the finger is not essentially necessary to a wide sale of automatic water heaters is demonstrated conclusively by the experience of a gas company whose practices are cited. This company makes a point of explaining to the consumer in advance that the really instantaneous feature is rather a figure of speech. Yet its success in selling water heaters has been consistently satisfactory in all respects.

Sincerity has been found to be a predominating quality in every really great salesman. There is no need of attributing any far-fetched merits to gas-burning equipment. We can sell our equipment for any purpose for which it is made, strictly on its own merits and leave a thoroughly satisfied customer behind us. The objections offered by the speaker in question are, in the mind of this journal, well founded and deserving of earnest consideration.

Speaking to the Public in Terms It Will Understand

The New Haven Gas Light Company has been achieving some gratifying successes in extending gas lighting. One reason for such results is revealed in a three-page folder which has been sent us by J. Arnold Norcross, its secretary and treasurer, which is addressed to architects, home builders and property owners. The New Haven Gas Light Company has acquired the ability to speak to the public in terms the public will understand; that will catch its attention and will hold its interest throughout the entire discourse.

One cannot more than glance at the folder without learning that the grand prize for the best-lighted exhibit at the Panama-Pacific Exposition was awarded to modern gas lighting; a fact not new to the gas man, perhaps, but a revelation to a public which the gas industry has permitted, though it should not have, to absorb to a great degree the notion that gas lighting is a relic of bygone days.

Many of us still harbor the delusion that we can simply cite efficiency and economy per candlepower hour and thereby sell gas lighting. Logically we should be able to. Our arguments are the essence of soundness. But their weakness lies in the fact that they are but vaguely understood.

The New Haven Company repeats the often-used expression: Gas is the best reading light. But it drives the statement home by declaring: "The free public library is piped throughout and is using gas advantageously for lighting."

Pyrometers—Past, Present and Future

(Continued from page 488)

Wire Diameter 0.02 Inch

Platinum-rhodium thermo-couples usually are furnished with wires of a diameter of two-hundredths of an inch. I can recollect, however, a thermo-couple of platinum rhodium with wires less than one-hundredth of an inch in diameter, which was used by the manufacturer of Welsbach gas mantles to run up and down over the delicate mantle to determine the hottest point of the mantle. The diameter of these platinum rhodium wires must necessarily be small on account of their great value.

If you should wish to make up a base metal thermo-couple and procure a coil of iron wire and another coil of a nickel copper alloy and make up a number of thermo-couples, and you later procure additional coils of the same wire to reproduce these thermo-couples, you would be surprised to find that the voltage produced by the various thermo-couples might vary as much as 50 deg. Fahr. at a temperature of 1400 deg. Fahr. If you should make up thermo-couples of nickel chromium wire, you would find that these would also vary as much as 30 deg. Fahr., that is, 15 deg. plus or minus, depending on the particular coils from which the wire was cut.

Reducing the Voltage at the Terminals

For a long time we attempted to duplicate the wire in order to procure thermo-couples which would reproduce the voltage of the previous thermo-couples, but this gave an excessive amount of trouble, and no great precision could be secured. Several years ago we adopted the policy of shunting each thermo-couple with manganin wire, reducing the voltage at the terminals of the thermo-couple about 2 millivolts. Each thermo-couple is adjusted in an electric furnace to a standard, and a maximum error of one-tenth of a millivolt or four degrees is permitted.

In this way a thermo-couple as sent out produces a definite voltage within 4 deg. Fahr., and we are not subjected to the trouble of endeavoring to reproduce exactly the voltage produced by each coil of thermo-couple wire. This method of shunting the thermo-couple also permits of the customer re-standardizing it at intervals. He can take the thermo-couple in constant service and check it up once a month or oftener in an electric furnace in comparison with a standard thermo-couple, and if the voltage has fallen off slightly, he can readjust the shunt accordingly. Instead of scrapping the thermo-couple, as in the past, because the voltage has fallen off slightly, they can be used again after adjustment.

Platinum Thermo-Couple Generates Little Voltage

Some other thermo-couples have resistance wire placed in series with the one side of the thermo-couple. I think this method is disadvantageous, since the resistance will only operate satisfactorily where the thermo-couple is used with instruments of exactly the same resistance, and they must be of low resistance. With the shunt method the voltage produced at the terminals of the thermo-couple will be the same whether used with a high or low resistance instrument.

This method of shunting thermo-couples has not been adopted with thermo-couples of precious metals, such as platinum and rhodium. This wire is supplied from uniform ingots and reproduces the voltage of previous melts. It would be desirable to have a shunted rare metal thermo-couple to permit re-standardizing after continuous service. The platinum thermo-couple, however, generates so little voltage at best that there is none to spare to permit of shunting the voltage produced by the thermo-couple.

Wires Must Be Insulated

The wires forming a thermo-couple must be insulated from each other throughout their length. This insulation must withstand high temperature, must be a good insulator, and must withstand reasonably severe handling.

A common method of insulating base metal thermo-couples is to wrap them with asbestos and paint the asbestos winding with a solution of sodium silicate.

Another method is to fit lava or porcelain beads over the thermo-couple wire, and I consider this a better form of insulation, as it does not disintegrate as rapidly as the asbestos insulation. For the platinum thermo-couple the insulation must be of porcelain or high-grade fire clay, free from impurities.

Life of Thermo-Couple Depends on Protecting Tube

The life which will be obtained from any thermo-couple installed in a furnace will very largely depend on the protecting tube over the thermo-couple. For temperatures up to 1200 deg. Fahr. a high-grade wrought iron tube gives satisfactory results.

The life of this tube can be increased by calorizing, a process recently developed by the General Electric Company, which impregnates the pipe with an aluminum oxide. This will increase the life of the pipe about three times where used at temperatures around 1400 deg. Fahr.

Tubes of nickel chromium give excellent results for temperatures as high as 1800 deg. Fahr., and they are to be recommended for the protection of base metal thermo-couples where the temperature exceeds 1200 deg. Fahr. Their cost is many times higher than the ordinary wrought iron pipe. It is about four times as much as calorized pipe, but their increased life would well justify the first increased cost.

Voltage Dependent Upon Difference in Temperature of Hot Junction

Platinum thermo-couples must always be protected with a tube which is impervious to gases, such as tubes of porcelain, quartz or alundum. Quartz tubes have a softening point at about 2400 deg. Fahr., but for temperatures below this they are the most satisfactory, as they will withstand sudden changes in temperature without breakage. Above 2400 deg. Fahr it is essential to use a tube of porcelain or alundum, and these tubes should preferably be protected with an extra fire brick or graphite tube, to prevent breakage of the porcelain or alundum tube with sudden changes in temperature. The fire brick or graphite tubes simply increase the lag slightly, but increase the life of the tubes and thermo-couples.

It is one of the properties of a thermo-couple that the voltage which it generates is dependent on the difference in the temperature of the hot junction, that is the one placed in the furnace, and the cold junction, which is the point at which the alloy wires of the thermo-couple join the copper leads of the instrument.

It is therefore particularly important that the cold junction be maintained at a constant temperature, for if a base metal thermo-couple is in use, and this cold junction increases in temperature ten degrees, the decreased voltage generated by the thermo-couple will cause the instrument to read ten degrees lower. If the cold junction decreases, the pyrometer will read higher to the same extent.

Until a few years ago no particular care was taken to take care of the source of error caused by changes in temperature at the cold junction of the thermo-couple. In recent years, however, it has been customary to run compensating leads of the same material as the thermo-couple to a distant point, where the temperature is uniform, instead of having the cold junction, just outside the furnace wall, where it might vary several hundred degrees. These compensating leads in duplex form with asbestos insulation can be run into a pipe driven into the ground, ten or fifteen feet, where the temperature will remain constant within five degrees, winter or summer. From my experience I consider this the best method to take care of cold junction temperatures, as it only takes a few hours to drive a piece of pipe into the ground, pointed at the lower end, and when once installed there is nothing to give trouble with this method.

Running Water Around Cold Junction

It has been common practice to maintain the cold junction at as nearly a constant temperature as possible by running water around it. This maintains the temperature at that of running water, which unfortunately may vary at least twenty to thirty degrees from winter to summer. This method has been very largely abandoned lately, and is hardly to be recommended.

Where it is impossible to place the cold junction in the ground, on account of the furnaces being on an upper floor of a building, a compensating box can be used, consisting of a lamp and thermostat, which will maintain the temperature constant within two degrees. These compensating boxes can be supplied to maintain the cold junction constant for any temperature from 50 to 150 deg. Fahr. The temperature for which the compensating box is set must necessarily be higher than the atmospheric temperature of the room in which it is located.

Some pyrometers are supplied now with resistance which is cut in or out by a switch to adjust by hand for the actual temperature of the cold junction at the end of the compensating leads. No matter what type of pyrometer is used in connection with a thermo-couple and compensating leads, the instrument must be adjusted for the actual temperature of the cold junction of the thermo-couple, whatever this may be, and the instruments have a zero adjuster to permit of adjusting the pointer for the correct cold junction temperature.

There are two distinct methods of measuring the voltage produced by a thermo-couple, i.e., the millivoltmeter method and the potentiometer method.

The Millivoltmeter Method

This instrument consists of a permanent magnet with its pole pieces, in the field of which a copper-wound coil swings in jeweled bearings. Instruments of the millivoltmeter type were in extensive use commercially abroad, and to some extent in this country, as much as twenty years ago, but the instruments were of such delicate construction as to be hardly suitable for general commercial use. Usually the instruments were supplied with the moving coils, hung between fine wire suspensions, and they were liable to be easily broken through jars or handling in transit. These instruments were of high resistance, approximately 300 ohms.

On account of the delicate construction of this type of imported instrument, a standard form of switchboard millivoltmeter, frequently used as an ammeter, came into extensive use about 1905, and these instruments are still used to-day. The instrument has a resistance of about five ohms, and each individual instrument must be calibrated for a thermo-couple of a certain length and for use with leads or wiring of a definite length. Slight changes in resistance, due to changes in the length of the thermo-couple, or length of the wiring, naturally affect the indications of the instrument, as the internal resistance of this type of millivoltmeter is so low. Serious errors are also liable to occur due to atmospheric changes in temperature along the wiring, which naturally affect its resistance. Actual tests show that with a low resistance millivoltmeter of five ohms, an atmospheric change in temperature from 50 to 100 deg. Fahr. along fifty feet of wiring from the thermo-couple to the instrument, will make the galvanometer read 18 deg. low. It is impossible to procure great accuracy with this type of instrument.

In the last few years it has been possible to develop a high resistance millivoltmeter, which for all practical purposes overcomes this trouble entirely. High resistance pyrometers of 300 ohms can be made to-day with pivoted jeweled bearings, and of robust enough construction to meet ordinary shop conditions, and an internal resistance of 300 ohms as compared with five ohms, for the low resistance pyrometer, will reduce to one-sixtieth the errors of low resistance instrument. A change in the atmospheric temperature along the wiring of 50 deg. Fahr. producing an error of 18 deg. Fahr., in a low resistance pyrometer of five ohms, becomes one-third of a degree where you have a resistance of 300 ohms. The millivoltmeter directly reads the temperature across the scale, and is calibrated in actual temperature degrees. It indicates the temperature from zero to the maximum scale range, and it relies entirely on the voltage of the thermo-couple for its operation. No outside sources of current are necessary.

Potentiometer Method

In this method of temperature measurement, the electro-motive force produced by the thermo-couple is measured by opposing to it, a known variable electromotive force, usually that of a dry cell contained in the instrument, so that when a balance is reached, no current flows. A galvanometer is used to indicate the point at which no current is flowing, and the pointer on the galvanometer then indicates zero, the voltage of the thermo-couple being opposed to the dry cell.

The resistance of the current from the dry cell to the galvanometer in the instrument is very small, and constant. After the thermo-couple voltage has been opposed to the voltage of the dry cell and balanced in the potentiometer, the actual measurement is that of the dry cell circuit; hence, this measurement is entirely independent of the resistance of the circuit, including the thermo-couple, lead wires and galvanometer. As a consequence, compensating leads can be run to the

instrument 500 ft. distant if desired. Changes in resistance of the various parts of the circuit, due to the changes in the length, or atmospheric changes, will not affect the indications.

The advantage of the potentiometer method of measuring temperature, is in its extreme precision, and its independence of resistance changes throughout the thermo-couple circuit. It has the disadvantage as compared with the millivoltmeter method that it is not direct reading, and that some outside source of current, a dry cell, for example, is necessary as a source of current to oppose the thermo-couple, and this dry cell must be replaced from time to time.

Radiation Pyrometers

The radiation pyrometer is a development of the thermo-electric pyrometer. Instead of placing the thermo-couple inside the furnace, where the temperature would be so high as to destroy it, it is placed in the back of a tube in front of a mirror. The rays of heat from the furnace enter the tube and strike the mirror and are brought to a focus on the thermo-couple junction. This attains a heat of only 200 or 300 deg. Fahr.

This instrument has a particular field where temperatures must be measured from 2,800 deg. Fahr. up, and it is possible to secure an accuracy within one to two per cent. with this type instrument, if the instructions as to its use are properly carried out. It is not recommended for service where a thermo-electric pyrometer with base metal or platinum thermo-couple can be used.

Methods of Standardizing Pyrometers

It is very essential, if accurate results are to be secured from pyrometers, that they be re-standardized at frequent intervals. If a thermo-couple is installed in a furnace and allowed to run for six months without being retested, sooner or later it will fail, and the user will find he is away off in his temperatures. This is simply caused by the falling off in the voltage of the thermo-couple with continuous usage. It is therefore of particular importance that the thermo-couples, whether base metal or platinum, be checked at frequent intervals. The frequency depends on the precision necessary in the work and the equipment available. Some plants make a point of checking their thermo-couples once a week, but it is advisable if this can be done at least once a month.

This checking can be very satisfactorily done by maintaining a standard platinum thermo-couple used for checking secondary standards of base metal. An electric furnace should be used not less than 10 in. deep so that a base metal thermo-couple can project at least 6 or 8 in. inside the furnace. The base metal thermo-couple can be tied together with asbestos string to the standard thermo-couple, with the junctions almost touching each other.

The thermo-couples should never be tested in their protecting pipe. A base metal thermo-couple should never be tested in a furnace with an insertion of less than 6 in., for the reason that the cross section or the thermo-couple wires is large, and the outer end of the thermo-couple wires in the cold air conduct the cold along the wires into the furnace and will reduce the indications at the thermo-couple junction on this account. The temperature of an electric furnace should be maintained constant for at least fifteen minutes before a reading is taken, and the tests should preferably be made at the working temperature of the thermo-couple.

Freezing Point of Salt an Excellent Testing Method

If the thermo-couple under test reads low, and it has no adjustable resistance, it will have to be junked. If it is furnished with a resistance for adjustment purposes, this adjustment can be easily made with a soldering iron.

The freezing point of pure salt is an excellent method of testing thermo-couples, or of the complete pyrometer consisting of the thermo-couple, leads and instrument. Insert a thermo-couple in a small crucible containing pure salt; ordinary table salt is satisfactory, and heat the salt to about 1,600 deg. Fahr. Remove the crucible from the heat and allow it to cool off. At the freezing point of the salt, which will be indicated by the temperature remaining reasonably constant for four or five minutes, the pyrometer should read 800 deg. Cent. or 1,474 deg. Fahr.

The melting point of a number of different metals is quite satisfactory for the checking purposes. The metals most generally used for this purpose, and their melting points follow:

Tin	450 deg. Fahr.
Zinc	787 deg. Fahr.
Silver	1,761 deg. Fahr.
Gold	1,945 deg. Fahr.

The Bureau of Standards at Washington is in good position to test pyrometers and thermo-couples for manufacturers in this country, and it is a good plan to have a standard platinum or base metal thermo-couple tested at the Bureau of Standards, and they can furnish the millivolt values for the thermo-couple. This can be retained as a primary standard to test the secondary thermo-couple. The cost of such a test by the Bureau of Standards is usually about $10, and the expense is well warranted.

The Future for Pyrometry

It would seem that the greatest development work in temperature measuring instruments will be done with the perfection of optical pyrometers, resistance thermometers and thermo-electric pyrometers. There is a field for a high-grade optical pyrometer which can be used by any number of operators, who will all secure the same results from the instrument.

Resistance thermometry will for some time continue to be limited to use at low temperatures unless some suitable metal is found for use in place of nickel to form the bulbs.

In thermo-electric pyrometry it is possible to develop better materials than those found to date for base metal thermo-couples. The insulation or protecting tube will be difficult to improve upon. With the direct reading millivoltmeter doubtless the resistance of these instruments will be greatly increased, and I know that we have spent an endless amount of development work the last year or two along this line, and other pyrometer manufacturers are doubtless doing the same thing. The more the internal resistance of the pyrometer can be increased, and at the same time maintain the robustness of the construction, the better the instrument.

With the potentiometer method of temperature measurement, doubtless development work can be carried on to advantage in producing an indicating instrument which will be direct reading throughout the scale range, and which will be simplified and less delicate than the types available at the present time.

Automatic Temperature Control

I think, however, the greatest future in pyrometry is along the line of automatic temperature control. I have with me here an instrument which automatically controls the temperature of this electric furnace. By means of solenoid operated switches the circuit is opened and closed through the rheostat, maintaining the temperature constant within 10 deg. Fahr.

We have one of these automatic temperature control instruments in use on a japanning oven at the Willys-Overland Company, in Toledo, and nineteen more under manufacture for them.

These instruments automatically maintain the temperature constant in an electrically heated oven, and this same type of instrument can just as easily be used on electric heat treating furnaces. We are experimenting with an instrument at present on an American Gas Furnace to operate gas valves, and control the temperature automatically, and while this instrument is in satisfactory operation in our own plant, it is not developed to a point where it is ready for general use.

In connection with this instrument, which I have with me, to automatically control the temperature of this furnace, you will note that we have rigged up two lights which indicate whether the temperature is high or low. This same instrument could be placed at each furnace and indicate to the fireman whether the temperature was correct or not. We can place a neutral point, ten or twenty degrees in width between the two contact points, operating these lights, so that both lights would be out when the temperature was correct and the red or blue light would flash to indicate if the temperature was too high or too low. We can also put a third contact in the instrument for this neutral point which will cause a white light to glow to indicate that the temperature is correct.

It is much easier to instruct a fireman to keep the white light burning and the other lights out than to get him to maintain 1,380 deg. on the pyrometer. He can see the lights from some distance, and these are easily understood by him.

Unfortunately, the help that is available to operate furnaces at the present time is frequently unable to read a pyrometer scale. There are a number of pyrometer equipments installed at automobile plants, particularly where the operator signals from a central point by lights at the furnace whether the temperature is correct or not. This instrument will automatically signal with lights.

I think it is only a question of time when we will have completed our development work with a switching device which will permit of one instrument operating the signal lights at a number of furnaces. It is only necessary to introduce the additional switching mechanism.

These are only suggestions to what is in store for the future.

Proper Installation

Before closing this paper I should point out to you from the position of the pyrometer manufacturer that one of the greatest difficulties experienced by us, and doubtless by other pyrometer manufacturers, is to induce the user of these instruments to properly install them. Very frequently this is left to some one who has absolutely no knowledge of pyrometers, and while he may attempt to follow the instructions of the manufacturer, they are not carried out in a very satisfactory manner.

Just before leaving Philadelphia one of our service men reported that he found a pyrometer equipment recently supplied by us giving incorrect readings, and when he investigated the cause for the trouble he found the equipment had been wired up throughout with small diameter iron wire uninsulated. Had the customer read the instructions, he would have observed that he should have used No. 12 gauge or larger copper insulated wire, and it is no wonder that he secured unsatisfactory results from such a wiring job. Co-operation on the part of the manufacturer to properly install the pyrometers, no matter what make they use, will reduce the sources of trouble from these instruments in the future.

Describes Experiences in Distributing Mixed Manufactured and Natural Gas

(Continued from page 491)

The rates charged in the city of Los Angeles have been as follows:

	Cents.
Just previous to July, 1911	80
July, 1911, to July, 1912	75
July, 1912, to July, 1913	70
July, 1913, to date	68

The reason for comparing 1912 to 1915 is that 1912 was the last full year that straight artificial gas was supplied, and 1915 was the first full year that the mixture of fifty per cent natural and fifty per cent artificial gas was served.

From time to time, since natural gas first came to Los Angeles we have been compelled in certain districts in order to maintain pressure during an emergency to turn into a district ordinarily supplied with a mixture of 50 per cent natural and 50 per cent artificial gas, and unmixed natural gas. The result of this during the winter of 1915-16 was not attended by any serious complaint from consumers. At that time our natural gas had a heating value of 1,120 B.t.u.'s and was received from Kern County Fields, an analysis of which is shown above.

During the years of 1916-17, however, the Southern California Gas Company obtained almost its entire supply of natural gas from the Whittier-Fullerton Field which gas had a heating value of 1,200 B.t.u.'s at that time, and when we attempted to turn this natural gas in to maintain the supply in a district formerly supplied with mixed gas, we did have considerable complaint.

When this was done, it meant that a considerable part of the district for several hours of the day was supplied with natural gas of about 1,200 B.t.u.'s and the remaining part of the day was supplied with mixed gas varying from 800 B.t.u.'s up, and the quality of gas was changed while the consumer was in the process of cooking meals.

The nature of those complaints seems to have been, when natural gas was on the district, of smoke and lamp black on the cooking utensils. When mixed gas was turned on the district, quite often the consumer complained of poor pressure, when as a matter of fact, the pressure was the same and the real cause was the reduction in the heating value.

Flash Back Troubles

During the year 1914, unmixed manufactured gas was substituted from time to time in some districts where straight natural gas had previously been served,

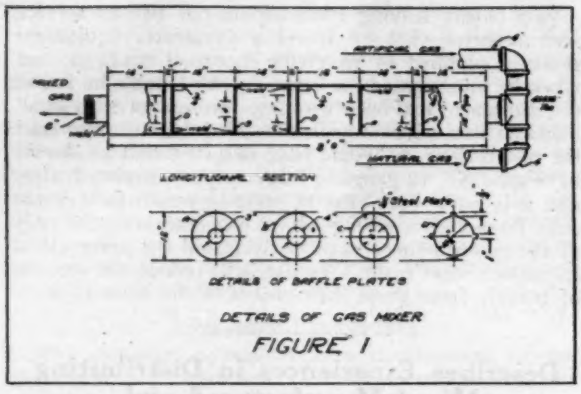


FIG. 1. SPECIALLY DESIGNED MIXING CHAMBER

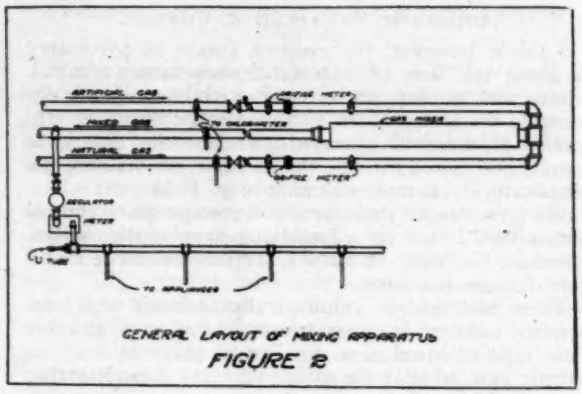


FIG. 2. SHOWING CONNECTIONS WITH NATURAL AND ARTIFICIAL LINES

and in other districts where a mixed gas had been served. It was found, that where pressures were maintained and the heat value of the manufactured gas was not allowed to go below 625 B.t.u.'s comparatively few complaints were received from the consumers, in spite of the fact that in some districts nothing but natural gas had previously been served.

We have found that where a stove is adjusted for mixed gas of 800 B.t.u.'s, and artificial gas of less than 550 B.t.u.'s is supplied that the stove will flash back and light in the mixers.

In order to determine the effect on consumers' appliances of different mixtures of artificial and natural gas we conducted a set of experiments, a brief description of which follows:

It was first necessary for us to be able to uniformly mix with our natural gas varying proportions of artificial gas, and to be able to maintain these mixtures during the experiments. For this purpose, we designed a mixing chamber consisting of a twelve inch pipe with baffler plate throughout its length. This is shown in drawing following marked "Fig. 1." "Fig. 2." shows how this mixer was connected up with the natural and artificial gas lines, gauges, gas appliances, etc.

The natural gas being passed into this mixture was received direct from the high pressure natural gas mains, and the artificial gas was compressed up to a pressure of about 35 lb. and the two gases after passing through the mixer were turned into the city mains.

The amount of gas being passed through the mixer was approximately 25,000 cu. ft. per hour. This mixer was also tested out passing 18,000 up to 30,000 cu. ft. per hour, and on pressures varying from 5 to 40 lb., and it seemed to mix the gas perfectly.

The meters used to measure the artificial and natural gas in the mixture were of the orifice type, which we use almost entirely for measuring high pressure gas throughout our system, and which we find to be most satisfactory.

In order to prove the effectiveness of our apparatus as designed for mixing natural and artificial gas, the heat units of the two gases being mixed were first determined, and then several tests were run on the gas after it was mixed in different proportions, and in each case the heat units obtained from the mixed gas corresponded to the heat units of its component parts. This is shown in the accompanying table.

Test No.	Art. Per Cent.	Nat. Per Cent.	B.t.u. Comp.	B.t.u. Cal.	Error of Comp. B.t.u.	S. P. Gravity. Comp.	S. P. Gravity. Machine.	Error of Comp.
1	56.3	43.7	788	810	2.8 less	....	....	
2	51.6	48.4	823	826	0.3 less	....	....	
3	79.2	20.8	592	597	0.8 less	....	....	
4	67.5	32.5	669	678	1.3 less	....	....	
5	59.8	40.2	767	808	5.3 less	.542	.540	.03 of 1 hi.
6	45.4	54.6	874	899	2.8 less	.575	.567	1.3 higher.

All tests were made with Hinman-Junkers calorimeters and the heat units reported are the gross heat units.

When we first began the introduction of natural gas, it was noticed that the admixture of natural gas with artificial materially increased the illuminating effect of the ordinary open flame burner, and in order to determine definitely what various proportions of natural gas would do to the illuminating power of the mixed gas when used in open flame burners, tests as per the following table were very carefully made in the following manner:

A five-foot Maryland meter prover was equipped with a double set of tin paddles revolving in opposite directions, somewhat in imitation of an egg-beater, for the purpose of thoroughly mixing the two gases. The required quantity of natural gas was accurately measured in the prover and the necessary amount of artificial gas was added to it.

To check all of the tests shown in the table, the method of procedure was reversed, — that is, the artificial gas was first measured in the prover, and the natural gas followed. Heat units and candle power were taken for each variation of percentage of natural gas, and the B.t.u. as well as the candle power is an average of the ten readings.

The candle power of the artificial gas at the time of these tests was 18.5 and that of the natural gas was 8.4 candles. It will be noticed that a general increase in illuminating power took place with the mixture of 5 per cent natural up to the point when 35 per cent natural was reached; thereafter a drop took place down to 70 per cent natural. From 70 per cent to

95 per cent no tests for B.t.u. were taken and the candle power determination was made rather difficult by reason of the streakiness and flickerings of the flame.

The writer is indebted to F. J. Shafer and B. G. Williams who are responsible for most of the work done on this paper.

EFFECT OF MIXED GASES ON CANDLE POWER AND HEAT UNITS

Per cent. of Artificial	Per cent. of Natural	Per cent. of Mixture	Candle Power	B.t.u.'s
100	...	...	18.5	620
...	100	...	8.4	1,055
95	5	100	19.1	631
90	10	100	19.7	658
85	15	100	20.2	685
80	20	100	21.0	701
75	25	100	21.1	724
70	30	100	21.2	753
65	35	100	21.5	768
60	40	100	21.0	791
55	45	100	20.0	809
50	50	100	19.3	839
45	55	100	18.2	861
40	60	100	17.7	878
35	65	100	17.3	904
30	70	100	16.4	917
25	75	100	15.3	
20	80	100	...	
15	85	100	14.1	
10	90	100	...	No test for B.t.u.'s
5	95	100	13.0	
...	...	...	11.2	
...	...	...	9.1	

Utilizes Heat in Gas Engine Exhaust Gas for Heating Building and Raising Steam

In his paper on efficiency in the operation of gas-compressing stations presented at the annual meeting of the Natural Gas Association of America at Buffalo, Thomas B. Weymouth described the following means of utilizing the heat in gas engine exhaust gases:

In the case of a 1,000 hp. unit operating at full load with an economy of 10,000 B.t.u. per horse-power-hour, the heat carried away from the engine in the exhaust gases will be about 2,500 B.t.u. per hp. at a temperature of about 1,000 deg. Fahr. Of this heat, it is possible to recover about 20 percent, or 500 B.t.u. per horse-power—a total of 500,000 B.t.u. for the unit. This is equivalent to almost 20 percent of the developed power of the engine, or 200 hp.

The heat thus recovered may be utilized in various ways. It provides an excellent means of heating the station buildings and has been used by the author for this purpose for several years, thus eliminating the old heating boilers with their attendant danger and waste of fuel.

This has been accomplished in two ways, the first of which was to carry the exhaust pipes through a closed conduit, permitting the fresh cold air to pass over them and thus become heated before entering the building. The second method, and the one now altogether used, consists in passing the exhaust gases through a specially designed hot water heater placed close to the engine, the water thus heated being allowed to circulate through direct radiators placed on the pump house floor.

Steam can be generated in this manner and utilized in various ways about the plant, such as in driving auxiliaries, additional gas compressors, or in absorption gasoline plants.

Gradual Exhaustion of Oil and Gas Has Stimulated Effort to Secure Deeper Producing Horizons

The gradual exhaustion of oil and gas has stimulated an effort to secure deeper producing horizons in regions in which compressor stations and pipe lines have already been constructed, declared A. R. Gray in his paper on "Deep Well Drilling" presented at the annual meeting of the Natural Gas Association of America at Buffalo.

That drilling to great depth can be successfully carried on seems open to little doubt. In 1860 when the search for oil and gas was actively begun in the Appalachian Basin, few, if any, wells were drilled as deep as 1,000 ft. In 1890 when development was at its height 3,000 ft. was considered an unusual depth. By 1910 several holes had been drilled to a depth of more than 5,000 ft. and at the present time at least two wells in the world have been drilled more than 7,000 ft.

In 1898 the Forest Oil Company drilled what at that time was the deepest well in the U. S. This well was drilled at West Elizabeth, Allegheny County, Pennsylvania, 12 miles southeast of Pittsburgh on the William Bedell farm. It was the intention to drill to the corniferous limestone, but owing to an accident the tools and 1,000 ft. of cable were left in the hole at 5,575 ft. Every effort was made to fish them out but without success; then an effort was made to dissolve the tools and cable with sulphuric acid, but after two years of effort the hole was finally abandoned.

Since the drilling of the Bedell well there have been at least a dozen wells drilled to a depth of from 4,000 to 5,500 ft. in addition to which the Hope Natural Gas Company has twenty-five deep wells located and drilling in West Virginia. It has completed eight deep wells at an average depth of 4,600 ft. below the Pittsburgh Coal. It also drilled one well to 6,390 ft. but unfortunately plugged the hole at that depth.

There is a well being drilled at Valcano, W. Va., in which this company has 4,000 ft. of 10-in. hole. Unless production is found, the well may be a very deep hole when completed as the great depth of 10-in. hole will give a good chance to continue. There is also a well drilling on the Goff farm near Clarksburg, West Virginia, in which there is already 6,500 ft. of 8-in. hole.

The deepest well in the world at the present time was drilled to a depth of 7,349 ft. at a location near Luchow, Germany.

The next deepest well in the world and the deepest in the U. S. is being drilled by the Peoples Natural Gas Company on the R. A. Geary farm in Washington County, Pa., near McDonald. At the present time this well is 7,247 ft. in depth and delayed by a fishing job.

Attleboro Company Gives Land for Garden

The Attleboro (Mass.) Gas Light Company has offered the use of a large tract of land on the west side of the main line of the New Haven Railroad from Thacher Street to the Ten Mile River for garden purposes.

A large part of this land is suitable for planting and is a welcome addition to the quantity offered for the same purpose by other firms in the city.

News of the Gas Industry

Fine Attendance Marks Twelfth Annual Convention of National Gas Association at Buffalo

Assistant Secretary Says Attendance Was Over 40 Per Cent. Higher Than Any Other Meeting

Although complete reports have not been received in time for publication on this date, some news of the success of the Twelfth Annual Convention has come through.

Up to Tuesday A. M. the attendance registered over 650 and the convention was in full swing. The program is expected to be followed as closely as possible all through the convention. One of the special features for Wednesday was an address on "The Mobilizing of the Industry for War" by E. C. Bedford, president Hope Natural Gas Company of Pittsburg, Pa.

The exhibitors report good business and plenty of live interest in their products.

The Cash Prize Contest has also met with good success and has been proclaimed a capital idea. An official booklet has been prepared containing all of the rules of the contest, with the questions to be answered. Each exhibitor was also allowed one question about his exhibit, the correct answer for which could be obtained by an inspection of the booth.

A more complete report with new officers and papers read will be given in the next issue of the journal.

New Blaugas Company Formed

Announcement has been made at the offices of Robinson & Company, 26 Exchange Place, New York City, of the incorporation under the laws of the State of New York of the American Blaugas Corporation, to succeed the Blaugas Company of Long Island City and the Eastern Blaugas Company of Portland, Me.

The new company owns all the patents formerly held by the Blaugas Company of America, and arrangements have been made to provide funds for a comprehensive development of the various departments of the industry.

George H. Robinson, who has been chairman of the reorganization committee, states that, after a thorough examination of the blaugas industry in this country extending over a period of several months, Charles H. Tenney & Company of Boston has agreed to undertake the general management of the new American Blaugas Corporation.

Charles H. Tenney & Company are managers of some 25 gas, electric and industrial enterprises, it is expected that their broad experience as engineers and managers of gas companies will result in greatly increased efficiency of operation of the Blaugas Company, as well as the development of new and important industrial uses for blaugas. This gas is to-day used in thousands of homes, schools and on farms, for lighting, cooking and heating, and for various industrial purposes also by metal workers who require a quick, safe and efficient gas to be used in conjunction with oxygen for cutting and welding metals for various purposes.

The executive offices of the American Blaugas Corporation are located at 25 Madison Avenue, New York City, and the officers of the corporation have been elected as follows: President, D. Edgar Manson, Brookline, Mass.; vice-president Palmer York, Boston; secretary and treasurer, Arthur S. Beves, New York City; general managers, Charles H. Tenney & Company, Boston.

Municipal Plant Raises Rates

Posted in the office of the Municipal Gas & Electric Department of Holyoke, Mass., was the following self-explanatory notice, signed by Manager John J. Kirkpatrick, announcing a raise in the price of gas:

"In order to offset the very much increased prices of gas-oil and coal the Gas & Electric Department is reluctantly compelled to increase the price of gas from 90 cents for 1,000 cu. ft. net.

"This new rate will go into effect on June 30, 1917, and will prevail until the prices of gas oil and coal become normal again. There will be no minimum charge on gas after that date."

To the Coal Operators of the United States

First Statement by the Council of National Defense, Committee on Coal Production

Under the act of Congress approved Aug. 29, 1916, providing that a Council of National Defense be established "for the co-operation of the industries and resources for the national security and welfare, to consist of the Secretary of War, the Secretary of the Navy, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce, and the Secretary of Labor," authority is given to the Council to organize subordinate bodies for its assistance and co-operation.

Pursuant to this authority the Council of National Defense has appointed Francis S. Peabody chairman of and with authority to appoint a committee on Coal Production, representative of the coal-producing districts throughout the United States. It is the intention that the members of this committee shall act as chairmen of sub-committees to be appointed by them in their respective districts.

The committee convened in Washington on May 9, at which time, in addition to the members of the committee, there were present Secretary of the Interior Franklin K. Lane, W. S. Gifford, director of the Council of National Defense, and Bernard M. Baruch, chairman of the Committee on Raw Materials, Minerals and Metals of the Advisory Board of the Council of National Defense, from whom an outline of the proposed scope of the committee's work was received.

In approving the appointment of this committee and laying before it the work that it was expected to do, Secretary Lane referred to the co-operative spirit already shown by the business men of the country in this mobilization of the resources of the United States. "It would surprise the nations of Europe to know how intense is the spirit of loyalty on the part of our business men and capitalists. . . . You are at the very root and foundation of the great industry — the war industry — that

presents itself on the other side of the water. . . . Now, there are two ways of dealing with a problem of this kind. One way is by the hearty co-operation of the men already engaged in the industry. The other way is by compulsion. My experience in the Interstate Commerce Commission led me to believe that the larger men in the railroad industry had quite as much vision as I had, and if I could show them the importance of an occasion they would try to meet it. So, instead of resorting to compulsion, instead of taking over mines and great operating plants, we are endeavoring to put you men at your best. This war is a challenge to us."

The country at the present time in the matter of its fuel production is confronted with a great emergency.

Notwithstanding the increased production of coal from practically every district, the increasing requirements to meet the needs of all classes of industry, as well as for the comfort and welfare of the people and the transportation of troops, munitions, food, and other products, together with the supplying of our allies, and for our national protection —all these demands are liable to surpass the capacity of our mines unless the full co-operation of the mining, transporting, and distributing agents of this country is secured. This emergency requires not only the development of the highest efficiency, especially on account of diminished supply of labor used in the production of coal, but also in more comprehensive methods of co-operation by the coal producers with the transporting and distributing agencies, so that not only a full production will be secured, but also that this production finds its way over our railroads into those centers where the most urgent need exists. If the demand for this product continues to increase it may be necessary that active steps be taken to so far as possible confine the distribution and use of it to those activities which are more nearly vital to the welfare and protection of the Nation. That this may not effect an unnecessary hardship upon the domestic welfare of our people it is necessary to promote the closest co-operation, and because of the duty laid upon us to promote this welfare we urge upon you that you co-operate with this committee in its efforts to promote the largest production, the most equitable distribution, and the highest use to produce the best economic results. No doubt an emergency exists, but it is the belief of this committee that with your hearty support and the assistance of the public in conserving supply, sufficient fuel can be had to meet public necessity.

We believe that the first essential toward an increased production of coal is a close co-operation between mine employer and mine employee, and inasmuch as the United Mine Workers of America and the mine operators in several districts have already pledged by joint resolutions to the Council of National Defense, under whom this committee works, and have nominated committees, the services of which have been offered to the Council of National Defense to this end, we now call upon the several committees to use their best and continued efforts to increase, in so far as they are able, the production of coal for the public necessities by keeping the mines continuously at work, avoiding labor disputes and unnecessary shutdowns. The operation of well-established mines should not be impeded and we suggest and urge that the practice of moving from the mines of well-established producing companies or communities to other districts be discouraged, as this practise creates a state of unrest and tends to decrease the total output of coal, interfering with the stability of the industry which is necessary for the highest efficiency. An effort should be made to instill in the mind of the individual miner and operator, as well as the organized body, the necessity of individual effort and continuous performance so far as work is offered. The miner or the company's representative who remains at work renders as patriotic service as the man at the front.

The total production of coal throughout the country has been seriously curtailed by difficulties in transportation service and unequal distributions of cars, resulting in shortage in the number of cars available for loading, as well as congestion in the avenues leading to the points of distribution. We urge upon the operators that they pledge themselves to load all cars obtainable in the shortest time after the same become available, and that they further take up and urge their customers to release these cars at the earliest possible date after delivery so as to make them available for further use, and that all practises such as unnecessary holding of cars for reconsignment or other purposes be discontinued except when absolutely necessary for public welfare.

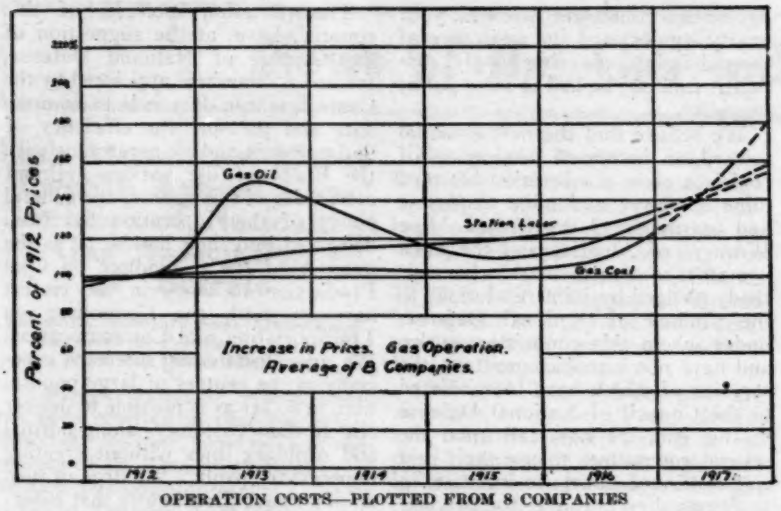
Transportation interests of this country, have, at the suggestion of the Council of National Defense, formed a committee appointed by the Council, whose duty it is to co-ordinate and promote the efficiency of our railroads and by agreement with the heads of the various railroad companies of this country the general policy of their operation has been delegated into their hands. It is the purpose of the Committee on Coal Production to work in the closest harmony with the Committee on Transportation and Communication. We urge distributing interests, especially in the centers of large population, in so far as is possible to deliver coal to their customers along normal and ordinary lines without creating unnecessary panic. We urge in turn upon all such distributors that information be sent to this committee of conditions in such cities as may be benefited by a closer co-operation of all concerned in our effort to supply all communities with their requirements.

If it is found that in any districts surplus coal is obtainable at this time over and above the actual needs, it should be divided as equally as possible and stored in the bins of the ultimate consumer so that the normal operation of the industry so far as is possible may be continuous, which will tend to prevent the necessary hardships which result from an unequal distribution of coal.

Already the centralization in the operation of our transportation lines which has been vested in its committee has proved of the greatest benefit to the coal industry, and we believe that a like centralization secured through this committee on coal production in all such matters as are furthered by the co-ordination of all interests will promote a still higher efficiency and be of greater benefit to producer as well as consumer.

Secretary Lane expressed to this committee the desire of the Government that the business men of the United States feel that the burden of carrying on this war rests in no inconsiderable part upon those who represent the genius of economic and industrial life. In meeting the present emergency you can build for the future betterment of the industry by stabilizing it along sound economic lines. Hearty co-operation between mine-worker and operator, and between producer and consumer expresses the best type of patriotism. The co-operation of the representatives of the Eastern semi-bituminous

(*Continued on page* 503)



OPERATION COSTS—PLOTTED FROM 8 COMPANIES

Cost of Materials

Some recent charts published in the Empire State Gas and Electric Association May Bulletin bring out some interesting data as furnished by ten gas companies operating in New York City. The chart for gas cost is shown above and is self-explanatory.

Second-Hand Well Equipment Soon to be Put on the Market

The Baur Gas & Supply Company, dealers in second-hand oil and gas well supplies, of Eaton, Ind., are now about to begin operations on the wrecking of about 100 gas and oil wells in the Bryant, Ind., gas fields.

While these wells continue to show a good production, the second-hand material is in such great demand that it appears advisable to wreck the plants and sell the material, which will soon be placed upon the market.

This journal is indebted to Albert E. Baurr for the foregoing information.

Increase Grant for Connecticut Company's Stock

In the House of Representatives at Hartford recently the bill permitting the Danbury & Bethel Gas & Electric Light Company to increase its capital stock to $1,000,000 was adopted. By the same measure the company is given authority to increase its bonds to three-fourths of the capital stock, or $750,000.

The bill had been reduced from the original request for permission to issue bonds to the amount of two millions, the chairman of the Committee on Incorporations stated. Assurances were given at the hearing that in the event of the granting of the increased capitalization a new gas plant would be erected in this city and the company's patrons would receive the benefit of lower rates for gas. The reduction in the authorized bond issue was made at the request of Representative Taylor, of this city, who contended that the issue originally asked for was greater than warranted.

New Jersey Bakery Installation Cuts Fuel Cost of 1,000 Loaves From $6.95 with Coal to $3.27 with Gas

A recent industrial installation made by the Public Service Gas Company of New Jersey in a large bakery in Newark has brought out some figures worthy of reproduction.

Last Fall five reel ovens were installed at Grandma's Bread Bakery in Newark and the following figures have recently been given in a letter signed by the bakery company, which show the difference in cost of operation between twelve cabinet ovens and five reel gas ovens:

NOVEMBER, 1915 (22 ROUTES)
BLODGETT OVEN

Coal	$85.00
Charcoal	40.00
Ash Cans	2.00
Carting of Ashes	3.00
Grates	6.00
Cement for Repairs	2.00
Fire Boxes	15.00
Labor (7 men)	480.00
Total	$633.00
Total Bread Baked	91,000

NOVEMBER, 1916 (16 ROUTES)
CRANDELL-PETTEE OVEN

Gas	$178.95
Electric	2.00
Labor (2 men)	160.00
Total	$340.95
Total Bread Baked	104,000

"The saving of expense is not the only advantage obtained by using the reel gas oven instead of the coal oven. Our biggest advantage is the fact that our bakery can, at all times, be kept clean without any extra effort on the part of the bakers, such as cleaning ashes from floor, removing ashes from ovens, removing the soot from the pipes and stoves. Another big advantage to be considered is the labor. In place of seven men for the coal ovens, we are now using only two men for the gas ovens. Then again, while it takes 50 minutes to bake 40 loaves in the coal oven, it takes only 40 minutes to bake 112 loaves in the gas oven.

"We were using 12 Blodgett ovens, 480 loaves to a baking, and we are now using five gas ovens, 560 loaves to a baking.

"Trusting that this information is satisfactory, we remain,

Very truly yours,
GRANDMA'S BREAD BAKERY."

This comparison means that the cost per 1,000 loaves with coal was $6.95, as against $3.27, with gas, or practically .007 per loaf for coal and .003¼ for gas.

Mock Trial Illustrates Safety First Principles

In order to inculcate in their employees a thorough realization of safety first ideas, the Montgomery Light & Water Power Company, operated by Henry L. Doherty & Company, held a mock trial, in which all the participants, including judge, lawyers, jury and court officials, were members of the company.

The basis of the "trial" was an action against the Doherty Company by one of its employees for injuries received, alleging contributory negligence on the part of the defendant company, which was denied. R. E. Steiner, attorney for the company, made an ideal judge, and in his charge to the jury explained in detail the virtues of safety first rules. The verdict of the court was in favor of a stricter observance of these regulations, and the trial itself was instructive in the manner in which the various points of the case were explained.

(*Continued from page* 501)
coal districts in agreeing to furnish the United States Navy with its next year's supply on satisfactory terms presents an example of the splendid spirit which we believe will characterize the coal industry as a whole. This is the patriotic opportunity for co-ordinated effort and co-operative service to the Nation. Therefore, we feel sure we can rely upon your hearty support.

F. S. PEABODY, Chairman,
Committee on Coal Production.

City of Clarksburg, W. Va., Handles Water at Low Cost

The cost of pumping water is made up of two principal elements, viz., first the fixed charges consisting of interest, repairs, maintenance and depreciation; and second, the cost of fuel. The fuel cost varies inversely as the duty of the engine, but on the other hand reciprocating engines showing the highest duties may also be the most costly, so that what is gained on fuel consumption may be lost in interest and depreciation charges.

For example, a comparison of the 1,100 hp. triple-expansion pumping engine at the Bissels Point Station, St. Louis, which upon test showed a duty of nearly 203,000,000 ft. lb. per 100 lb. of steam, with the 1,200 hp. steam-turbine-driven pump at the Kirtland Station of the City of Cleveland, which showed a duty of slightly over 152,000,000 ft. lb. per 1,000 lb. of steam, developed the fact that the unit showing the lower duty was the more economical. The total cost of the reciprocating equipment, including buildings, foundations, boilers and boiler plant complete, was about $195,000, while for the steam-turbine-driven centrifugal pump, it was about $84,000. Assuming both stations to use coal costing $1.70 per ton, the total cost of pumping with the centrifugal pump was $23.08 per water horse power year, of 365 days of 24 hours each, as against $27.60 for the reciprocating pump. Of these amounts, approximately $17.50 for the centrifugal pump and $13.50 for the reciprocating pump represented fuel.

In some localities natural gas of high heat value can be obtained at remarkably low cost. Taking advantage of this fact and of the superior efficiency of the gas engine as compared with the steam engine, the City of Clarksburg, W. Va., has been able to reduce the fuel cost of pumping to about $7 per water horse power per year.

The pumping equipment recently put in service at Clarksburg by Dravo-Doyle Company of Pittsburg consists of a 50-hp. gas engine driving through speed increasing gears a 4,000,000 gal. per day De Laval Centrifugal pump, which delivers water against 35 ft. head to the filter bed, and a 350 hp. gas engine running at 200 r.p.m., driving through double-helical speed-increasing gears a De Laval two-stage centrifugal pump, delivering 4,000,000 gal. per day against 350 ft. head to the city reservoir. The latter unit is illustrated herewith.

GAS - ENGINE - DRIVEN CENTRIFUGAL PUMP AT CLARKSBURG, W. VA.

The gas engine was guaranteed by the maker to deliver a brake horsepower on 10 cu. ft. per hour of gas of a heating value of 1,000 B.t.u. per cu. ft. During a ten days' continuous run the total consumption of the high service and low service pumps together was found to average 82,200 cu. ft. of gas per day. During this run the capacity was kept up to 4,100,000 gal. per day, the high service pump delivering against about 330 ft. head, and the low service pump against 30 ft. head, a total of about 258.5 water horse power. The gas is received from wells nearby belonging to the city and is charged for at 6 cents per 1,000 cu. ft., although the commercial power rate in that locality is about 8 cents. The fuel cost of a water horsepower would be $6.96 per year at 6 cents and $9.27 at 8 cents.

Formerly water was supplied by engine-driven centrifugal low-service pumps and duplex direct-acting high-service pumps, receiving steam from gas-fired boilers. With this equipment the gas consumption was about 350,000 cu. ft. per day, at a pumpage rate of approximately 3,000,000 gal. When additional capacity and new equipment became necessary, the Clarksburg Water and Sewage Board and their engineer, George W. Fuller, made a careful investigation of the following: Steam-driven centrifugal pumps, steam-driven crank and fly-wheel pumping engines, gas-engine-driven direct-acting pumps and gas-engine-driven centrifugal pumps.

The preliminary estimates showed that the best gas consumption with steam-driven pumps would be about three times that of gas-engine-driven pumps and, in view of the rapid depletion of the natural gas supply in the neighborhood, it was deemed advisable to put in the more economical, although more expensive, equipment in order that the city's gas wells might last as long as possible.

The complete cost of the pumping equipment was approximately $17,500. The cost of the substructure, superstructure, crane, piping and appurtenances complete was $13,905, or a total of $31,405. The annual interest, depreciation and upkeep charges upon this amount at 8 per cent. would be $2,512.40 per year, or $9.71 per water horsepower, giving a total cost of pumping, exclusive of attendance and supplies, of $16.67 per water horsepower year of 365 days of 24 hours each. For 16-hr. operation the cost would be $14.35. These figures compare favorably with those previously cited for much larger steam-driven pumping units.

Terre Haute Company Increases Capital Stock

Notice of the increase of the capital stock of the Citizens' Gas & Fuel Company, from $375,000 to $800,000, was filed with County Recorder John T. Grace, recently. The value of certain of its common capital stock was increased from $50 to $100 per share, and a $300,000 issue of non-voting, six per cent. stock, was changed to a $300,000 issue of voting, seven per cent. stock.

Previous to the change the par value of the common stock was $375,000 and it was held as follows: United Gas & Electric Company, $367,500; John T. Beasley, $1,300; Demas Deming, $1,200; W. S. Rea, $1,000; B. V. Marshall, $1,000; C. D. Shaul, $1,000; S. J. Dill, $1,000; M. D. Evans, $1,000.

Authority to increase the stock was granted by the public service company some time ago, and covers improvements already made.

The JAMESTOWN GAS COMPANY, Jamestown, Ind., filed preliminary certificate of dissolution.

Sioux City Adopts Heat Unit Standard

The ordinance placing the testing of gas furnished to Sioux City, Ia., people on the basis of heat units instead of light units, and the abolition of the candlepower requirement, was passed by the city council recently. It is granted that the elimination of the restriction will give the company an opportunity to give better heating gas, and gas which will develop more illumination when used with incandescent mantles, in the absence of the candle-power restriction.

Manitowoc Company May Move and Enlarge Plant

Removal and enlargement of the plant of the Manitowoc (Wis.) Gas Company is probable next year.

The council was so informed by the sanitary committee in report at the last meeting on the petition of property owners in vicinity of the present plant for abatement of smoke. The committee said it was informed the company had to enlarge its plant and would have a new location next year. For this reason no action was taken on the petition.

Society of Gas Lighting

Minutes on the Death of Walter A. Allen

Your committee appointed at the April meeting to draft a minute in memory of Walter A. Allen beg to submit the following:

In the unalterable course of human events there occurred on March 28, 1917, at his home, 323 Decatur Street, Brooklyn, the demise of our friend and member, Walter A. Allen.

Mr. Allen was born in Staten Island Aug. 31, 1846, and was therefore at the time of his death in his 71st year.

He was one of three brothers who have been connected with and made their mark in the gas industry.

A seventeen-year-old youth, fond of the sea, he shipped as an apprentice on one of our famous clipper ships for a voyage around the Horn. Arriving eventually at San Francisco, he found the Civil War raging in full blast and enlisted in the California Cavalry. He served with them for three years, seeing and participating in considerable fighting, largely in the Indian country, Kit Carson acting as a guide.

Disabled by a bullet wound in the hip, he quit the soldier's life and came East again, living for some years at Springfield, Mass.

Mr. Allen made his entry in the gas business by accepting a position with the Fulton Municipal Gas Company when their works in Brooklyn were started, about 1880. Some years later, when the parties dominating this concern obtained control of the Albany (N. Y.) Gas Company, he was called to the latter city as superintendent of their plant.

Upon the death of his brother Henry in 1894 he took his place of engineer and superintendent of the Mutual Gas Light Company of New York City. Failing health compelled him to resign this position in 1911.

He became a member of this society in December, 1894. In 1912 he was made a Life Member. During the years when he enjoyed good health he was a regular attendant at our meetings, taking a deep interest in the proceedings.

Mr. Allen was one of the class of men who, through native talent more than through preparatory education, mastered the theory and practise of our profession, even though he entered it comparatively late in life. He was a man that has rendered good and faithful service to his employers, was esteemed by all he came in contact with, and a man that, in our circle, will always be remembered as a good, warm-hearted friend, quiet and unassuming though he was.

(Signed) E. G. Love,
Alex. H. Stroeker,
R. W. Bush.

Societies and Associations

The Pacific Coast Gas Association held its first Get-together dinner of the season in San Francisco on the evening of Thursday, April 5. There was an excellent attendance of members from all parts of the Pacific Coast territory, and the ballroom of the Palace Hotel, in which the banquet was held was appropriately draped with the national colors. It was one of the most enthusiastic gatherings ever held by members of this Association. President C. B. Babcock, lately returned from his trip East, was in the chair. The chairmen of the various standing committees reported progress, and among those called upon for remarks were E. C. Jones, Henry Bostwick, John D. Kuster, F. A. Leach, Jr., F. S. Myrtle and M. L. Neely, all of "Pacific Service"; Leon P. Lowe, F. A. Cressey, Jr., Wm. J. Dorr, T. P. Brooks, R. L. Cardiff and H. R. Basford. All of the speeches were to the point and were well received.

A feature of the evening was the adoption of the following resolutions which were transmitted by telegraph to the President of the United States at Washington and the Governor of California at Sacramento:

"*Resolved*, That the Pacific Coast Gas Association, in meeting assembled, tenders to your excellency the united, loyal and patriotic support of its membership, to be of such assistance to you and our nation as necessities may demand. The organization is composed of technical men who are used to problems and their solution, and bring with them in this tender of patriotic services the best wishes for you and your Administration, with the assurances of loyal esteem and support."

Needless to say the adoption called for "The Star Spangled Banner," which was given with a will. It is with great pleasure that the receipt of the following reply from President Wilson is announced:

"The President thanks you cordially for the good-will which prompted your kind message which has helped to reassure him and keep him in heart."

An expression of sympathy and affection was transmitted to Frank A. Cressey, Sr., a charter member of the Association and father of the Past President, who is confined to his home at Modesto by serious illness.

The Association is now on the eve of the quarter-century mark, and while there are several of the "Old Guard" still on hand, its future destiny must rest with the younger men of the industry. That being so, it is refreshing to note the number of new members that the Association is enrolling. "Good Old Reliable Gas" is doing business with greater energy than ever; in fact, from all accounts the industry is entering upon a new era of progress and prosperity. Gas men realize that they are to play a most important part in the industrial development of our country.

The second Get-together dinner of the Association is scheduled for Los Angeles on the evening of Saturday, June 9. It has already been announced that the Association will hold its Twenty-fifth Annual Convention at Santa Cruz.